

## EDITORIAL COMMITTEE

**SHYAM SUNDER SHARMA**

Editor, *Vidyay Pragati*  
C.S.I.R., New Delhi

**HADIUDDIN KHAN**

Editor, *Invention Intelligence*  
National Research Development Corporation of India  
New Delhi

**A. RAHMAN**

Chief, Planning, C.S.I.R., New Delhi

**S. ISRAEL**

Director  
National Book Trust of India, New Delhi

**C.N.R. RAO, Professor**

Indian Institute of Technology, Kanpur  
(Representative, Department of Science and Technology)

**ASHRAF**

Associate Professor  
Jawaharlal Nehru University, New Delhi

**A.N. BOSE**

Head, Department of Education in Science and Mathematics  
NCERT, New Delhi

**D. LAHIRY, Reader**

Department of Education in Science and Mathematics  
New Delhi

**CHHOTAN SINGH, Reader**

DESM, NCERT, New Delhi

**K.M. PANT, Reader**

DESM, NCERT, New Delhi

**K.M. S. MAZUMDAR, Lecturer**

DESM, NCERT, New Delhi

**R.C. SAXENA, Reader**

DESM, NCERT, New Delhi

**Chief Editor: Prof. A. N. Bose**

**Associate Editor: Dr. D. Lahiry**

**Editor: Santo Datta**

**Editorial Assistant: J. P. Sharma**

## SUBSCRIPTION

*Annual* Rs. 8.00

*Single Copy* Rs. 2.00

# School Science

Vol. XXV, No. 1  
March 1976

A QUARTERLY JOURNAL OF SCIENCE EDUCATION

## CONTENTS

### 1. EDITORIAL

Jagannay Mitra	3	Amedeo Avogadro—Bicentennial Reflection
L. D. Ahuja	6	Corona Chemistry
B. K. Sharma	10	Raman Effect and its Applications
H. S. Vink	14	Teaching of Science in Punjab Schools: A Critical Survey
P. K. Bhattacharya	19	Mini Workshop on a Bicycle
	25	Ivan Pavlov
	26	Albert Einstein
A. C. Chaudhri	27	An Inexpensive Microscope
S. Ramaswami Iyengar	29	Some Arithmetic Tables
	33	BOOK REVIEW
	36	SCIENCE NEWS
	47	SCIENTIFIC TERMS

## TO OUR CONTRIBUTORS

**School Science** is a quarterly journal intended to serve teachers and students in schools with the recent developments in science and science methodology. It aims to serve as a forum of exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc., should be neatly typed, double spaced on uniformly sized paper, and sent to the Editor, **School Science**, Department of Science Education, NIE Buildings, Sri Aurobindo Marg, New Delhi 16. Each article may not normally exceed 10 typed pages.

The articles sent for publication should be exclusive for this journal. Digests of previously published articles modified to suit the scope and purpose of **School Science** will be accepted. In these cases the name of the journal in which the original article appeared must be stated.

Headings should not be underlined.

Selected references to literature arranged alphabetically according to the author's name, may be given at the end of the article, wherever possible. Each reference should contain the name of the author (with initials), the title of the publication, the name of the publisher, the place of publication, the volume and page numbers.

In the text, the reference should be indicated by the author's name followed by the year of publication enclosed in brackets, e.g. (Passow, 1962). When the author's name occurs in the text, the year of publication alone need be given in brackets, e.g. Passow (1962).

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of post-card size, and should be sent properly packed so as to avoid damage in transit.

---

## EDITORIAL

---

AT THE NOISY MEETINGS of the NCERT workshops goes on the preparation of curricular materials in different subjects, which are meant to be the national model. Some states are also at it in their own way. Gradually, different ingredients of the model—the syllabi, texts, teachers' guides and test items develop.

If adoption of a uniform curriculum frame-work for this country is any achievement, the preparation of the actual curricular material in science, on the basis of the given guidance, is a stupendous task because this is directly related to the classrooms.

Gone are the days when teachers were concerned exclusively with the act of teaching science information, prescribed by a few experts; evaluation was made through an annual examination. It was a common practice to assign narrow topics by grade levels or to take up one entire discipline in one class and others in the subsequent classes. Some times the factual information within the topics taught were of a trivial nature and unrelated to the other components of the curriculum.

With the rapid growth of knowledge in science, nagging problems continually appeared. What should be taught and what should be left out? How best can we teach science, so that the children do not forget so much so quickly after they have been taught? How can we instill scientific attitude and impart skill of application that are so much wanting in our daily life?

These issues of science education have been repeatedly examined and reviewed. We are still concerned with the acquisition of scientific knowledge. But we realize that for effective functioning, the acquiring of thinking skills and attitudes should receive as much emphasis as the facts and principles of science have received so far. In India, modern practices in planning the science curriculum are the result of organized educational activity of the last few years. In the advanced countries the trend is older. Although we can be benefited from their experience, we cannot transplant their ideas. The basic nature of some of our problems are different. Our limitations are manifold. Moreover, the basic issues of science education are yet far from settled.

Since the late fifties in the advanced countries, and in the late sixties in ours, we have seen a spate of activities in science curriculum revision. In the face of accelerating growth of science the 'processes' of science became more important. How else can we accommodate the required content and scrap off the dead wood?



Under the Government patronage, study groups have been formed in order to involve working scientists. International collaboration was obtained and funds were provided. The participation of specialists in science and education have greatly increased. A climate of change has been created. We have evolved the mechanism for improving science education.

The guidance for what to teach obviously comes from the field of science itself. The scientists have repeatedly asserted that scientific knowledge and principles are not unconnected information; they are meaningfully related. Conventional boundary lines are fast fading out and at best they can be perpetuated for specialization. The scientists are increasingly stressing on the need of fusion of disciplines and advocating an integrated approach in science education, which we are trying to evolve. Cooperation of different disciplines have been sought.

To what extent the study of inventions should make room for the basic principles? The education experts are to carefully weigh the importance of broad generalizations and skills, which are otherwise useful, but may prove to be difficult without laboratory practice and become uninteresting unless they are related to a concrete product. We cannot at the same time, rely too much on the approach 'learn-now-you-will-see-the-value-later'. It is important to make the subject of studies meaningful throughout their course. The children feel much more at home with concrete situations than with theories separated from their experience. Yet, we cannot forget the urgency of attaining the short-range goals.

The teacher educators and educational administrators are to carefully consider how much they can put in in the form of equipment and teachers' training facilities to enable the teacher to impart scientific skills. What are the 'products' of science that we can choose to draw the interest of the rural and urban children? The teacher at this point may give us a hand. The most ticklish problem, of course, is to choose science topics which will have social relevance to the children of different socio-economic groups and will make their studies meaningful.

Preparation of a good science curriculum, therefore, requires talents from various fields. In addition to the important role of the scientists and science educators, contributions are needed from the classroom teachers, teacher educators, educational administrators and writers. We have already associated a broad spectrum of talents at different stages for this challenging national assignment. It is not a mean job to find out exact areas of science and proper presentation that will help in understanding important scientific generalizations and social transformation, keeping the interest of study alive. We look forward with confidence. ☐

# Amedeo Avogadro

## —Bicentennial Reflections

JAGANMAY MITRA

Reader, Department of Education in  
Science and Mathematics, NCERT

IGNORANCE and biased attitude often halted the progress of science in history. Many scientific discoveries remained unknown and the discoverers went unnoticed for many years.

Amedeo Avogadro, one of the great scientists of all times, was such a scientist and his concept of molecule was such an epoch-making discovery that went unnoticed for a long time. This later came to be known as Avogadro's hypothesis. The acceptance of his hypothesis by the scientific community, at last, cleared up the mist of confusion that was prevailing in the contemporary science for about fifty years and provided a new momentum to the progress of science in general and the science of chemistry and physics in particular.

Lorenzo Romano Amedeo Carlo Avogadro Quarequae di Cerreto, in short, Amedeo Avogadro, was born on 9 August 1776 in Turin,



Italy. He came of an Italian family of eminent ecclesiastical lawyers. It was decided that Amedeo would take up his father's profession. He was a brilliant student and got his bachelor's

degree in jurisprudence in the year 1792. About after four years, he became doctor of ecclesiastical law and entered into the legal profession. He did not continue long in that profession.

In 1800, he devoted himself to the study of mathematics and physics. He could draw attention of the local scientists for some original work on electricity during the early part of his research career. But, as a scientist, he was little known in Italy.

At the age of thirty-three, Avogadro started his career as a university academician and became Professor of Philosophy in the Royal College of Vercelli in the north of Italy. In 1820, he got the first Italian chair of mathematical physics at the University of Turin and held the chair for about two years. His life as an academician in the university was interrupted by wars and revolutions and the changing political situation in Italy. From 1822 for about ten years the post was suppressed due to political turmoils. With the restoration of this chair of professorship in 1832, it was held for about a year by the distinguished French mathematician Cauchy. The chair was re-occupied by Avogadro from 1834 until his retirement in 1850.

In 1811, Avogadro published a paper on the concept of molecule in the French journal, *Journal de Physique* which escaped notice of the scientific community for over fifty years. The ideas he had propounded in that famous article were vital to the advancement of the science of chemistry and physics. But this paper had to wait decades to draw the attention of the scientists. Avogadro made clear distinction between molecules and atoms. What he described as 'integral molecules' are today's 'molecules', and his 'elementary molecules' are today's 'atoms'. He made the assumption that the atoms of a simple gas could combine with each other, and while reacting with another

gas, the resultant integral molecules could split up to form new integral molecules having different compositions. Almost a similar hypothesis was put forward by the French physicist Ampere in 1814.

Avogadro advocated the idea that equal volumes of any two gases contained equal number of molecules under the same conditions of temperature and pressure. Long before the chemists had worked out the methods of measuring the molecules he stated :

It must be admitted that very simple relations also exist between the volumes of gaseous substances and the numbers of simple or compound molecules which form them. The first hypothesis to present itself in this connection, and apparently even the only admissible one, is the supposition that the number of integrant molecules in all gases is always the same for equal volumes. The ratios of the masses of the molecules are the same as those of the densities of the different gases at equal temperature and pressure, and the relative number of molecules in a compound is given at once by the ratio of the volumes of the gases that form it.

John Dalton, the great scientist of that time, who was famous for his atomic theory, casually considered the assumption but rejected it.

In a long supplementary paper, Avogadro correctly deduced the formulae of  $\text{COCl}_2$ ,  $\text{H}_2\text{S}$ ,  $\text{SO}_2$ ,  $\text{CO}_2$ ,  $\text{CS}_2$  and a number of other compounds. But unfortunately this work was mostly overlooked by the contemporary scientists.

If Avogadro's simple and logical reasoning in favour of his ideas had been accepted at that time, the chemists could have avoided about half a century of confusion and contradiction.

The progress of chemistry was at an impasse. But at the time when Avogadro proposed his hypothesis, there were hardly enough available facts to substantiate its validity. This was one of the important reasons for which his hypothesis suffered long neglect. It was correctly pointed out by Kopp that scientists would have paid more attention to his hypothesis if Avogadro had put forward some more experimental data.

With the accumulation of more and more facts created more confusion subsequently, because there was no adequate theory to explain them. And by 1860, the situation was so deplorable that each individual chemist started using his own method of writing chemical formulae. With a view to resolving this controversy and confusion, Kekule felt that a convention of the chemists from different countries should be called. Carl Weltzien, a friend of Kekule, decided to organize the meeting of chemists at Karlsruhe in Germany. This was the first International Chemical Congress. The meeting was held on the 3 September 1860, to find agreement on disputed points. Stanislao Cannizzaro, Professor of Chemistry at the University of Genoa—Avogadro's countryman and a great protagonist of his ideas—took the fullest advantage of the unpreparedness of the participating scientists of the Congress and spoke strongly in favour of Avogadro's hypothesis. Cannizzaro was conversant with the hypothesis as he had

regularly used it in his university course. The content of this course he had already published in the official journal of the University of Pisa and brought the reprints of that paper with him to the Congress. At the end of the session, when the participants were leaving the Congress with as great a confusion of mind as they had come with, Cannizzaro's friend Angelo Pavesi of the University of Pavia distributed the reprints. In his paper, Cannizzaro made a unique review of the historical development of the concepts of atoms and molecules, and showed how the various parts of Avogadro's hypothesis and proposition had been accepted by Gerhardt, Dumas and Berzelius. But none of them accepted the hypothesis in its totality.

With the passage of time, the arguments put forward by Cannizzaro started convincing the eminent chemists of his time. Thus, the untiring efforts of Cannizzaro brought the recognition for Avogadro as the discoverer of molecules, years after the death of the genius on 9 July 1856. Cannizzaro, for his contribution to science, was duly honoured with the award of Copley Medal of the Royal Society.

Hundreds of scientists from almost all the countries of the world assembled in Turin, Italy, in the year 1911. They gathered there to unveil a monument to commemorate the 100th anniversary of the publication of Avogadro's hypothesis. Let us pay homage to this great scientist who laid the foundation of molecular chemistry. □

# Corona Chemistry

L. D. AHUJA

Chemistry Department, I.I.T., New Delhi

ALL OF YOU know that gases are electrical insulators. But in a very strong electric field, gas molecules become ionized and conduct electricity. The electric discharge through rarified gases, an electric arc between two carbon electrodes and the striking of lightning from a thundering cloud to earth, all these are familiar to the science students.

However, if a solid dielectric or an insulating barrier is placed between two such electrodes, no arc develops. The barrier interrupts the conductive path and allows only an incomplete breakdown of the gas. Instead of a hot localized arc, there appears a cooler, diffused glow between the electrodes.

This soft, bluish discharge indicating the incomplete breakdown of a gas at or near atmospheric pressure is called Corona. In electrical technology, corona is usually a sign of trouble. For example, when a glow appears along a high-voltage power line in a bad weather, it means that power is being lost. Chemists have employed it as a versatile chemical catalyst.

The idea of utilizing corona for producing chemicals is about 100 years old but the only commercially significant development of early work on corona was the production of ozone by subjecting oxygen to an electric discharge.

It was only during the World War II when attempts were made to generate high frequency power at a reasonable cost. Dielectrics such as fused quartz, alumina and mica became available. Improved electronic circuitry made it easy to control the corona power. But most of these efforts were directed towards producing electron beams, electrical plasmas and nuclear radiation. It was only around sixties that emphasis on the effects of radiation on chemical reactions was made. The purpose has been to create free radicals. The difference between the corona chemistry and radiation chemistry is one of electron energy. Whereas radiation chemistry uses energy of the order of million electron volts, corona chemistry makes use of only 10-25 electron volts. This makes the corona energy less expensive. Whereas high energy radiation can penetrate deep into liquids and solids, corona is purely a gas phase phenomena as it produces free radicals in a gas or mixture of gases. In some cases, the radicals can interact with molecules of a liquid or of a finely divided solid which is subsequently exposed to them.

## Corona Cells

One of the primary tasks of corona technology is to design the corona cells or corona reactors. The simplest situation is one in which both the starting material and the products are gases. In such a case, the reactor can consist simply of an assembly of closely spaced insulated plate or insulated tube electrodes between which the corona is generated and the gases pass (Fig. 1). The product

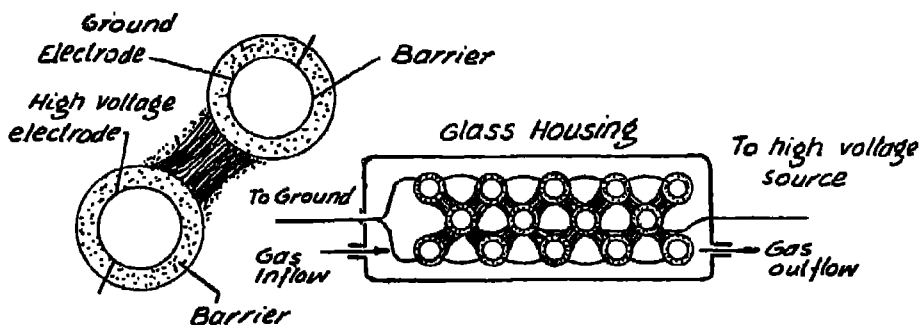


FIG. 1. Tube Electrodes of a Gas Reactor

molecules are continuously removed from the mixture of gases that flows out of the reactor and the starting gas is recycled, so that further conversion can take place.

#### *Use of Corona*

Corona is effective in a wide variety of reactions. The synthesis of ozone suggests a number of similar reactions in which simple molecules are converted into more complex ones with higher energy. Hydrogen peroxide which was earlier made by low-voltage electrolysis, was tried by German chemists by employing corona synthesis. In corona, a molecule of water vapour decomposes into a free hydroxyl radical and an H atom. Two hydroxyl radicals then combine to form  $H_2O_2$ .

Hydrazine, an important rocket fuel, can be produced by corona discharge in ammonia gas. The  $NH_3$  is dissociated into an amino radical  $NH_2$  and a hydrogen radical which in turn makes another amino radical by producing a hydrogen atom from another ammonia molecule. Two amino radicals then combine to form hydrazine ( $N_2H_4$ ).

Corona has special properties as the synthesizer of highly reactive compounds. There are a number of oxygen fluorides which are so unstable that they break down at the very temperature at which they are synthesized.

By operating corona at low temperatures, it is possible to synthesize such fluorides. This technique prevents the breakdown of the products formed. With this technique, the well known unusual compounds like xenon fluorides, etc. were prepared. For these applications, liquid gas reactors are used, the design of which is given in Fig. 2.

#### *Industrial Applications*

The low-cost corona power encouraged its use in water purification, polymerization and cracking of petroleum and coal. Corona playing on water forms hydroxyl and hydro-peroxyl radicals ( $HOO$ ) at the surface. These radicals diffuse into water where they kill bacteria by interfering with their metabolic process. Even the detergents are attacked and converted into innocuous molecules such as  $CO_2$  and water. One attractive prospect is the use of corona to deposit a thin film of polymer as coating on sheets of metals, plastic or cloth.

Sulphur in a fuel oil is a source of air pollution. Even in coal, the sulphur bonds appear to be split by corona more readily than any other bonds. Hydrogen sulphide is one of the products of corona attack on coal. The production of gasoline and oil from coal by hydrogenation, attempted by the Germans in the Second World War, was found to be an

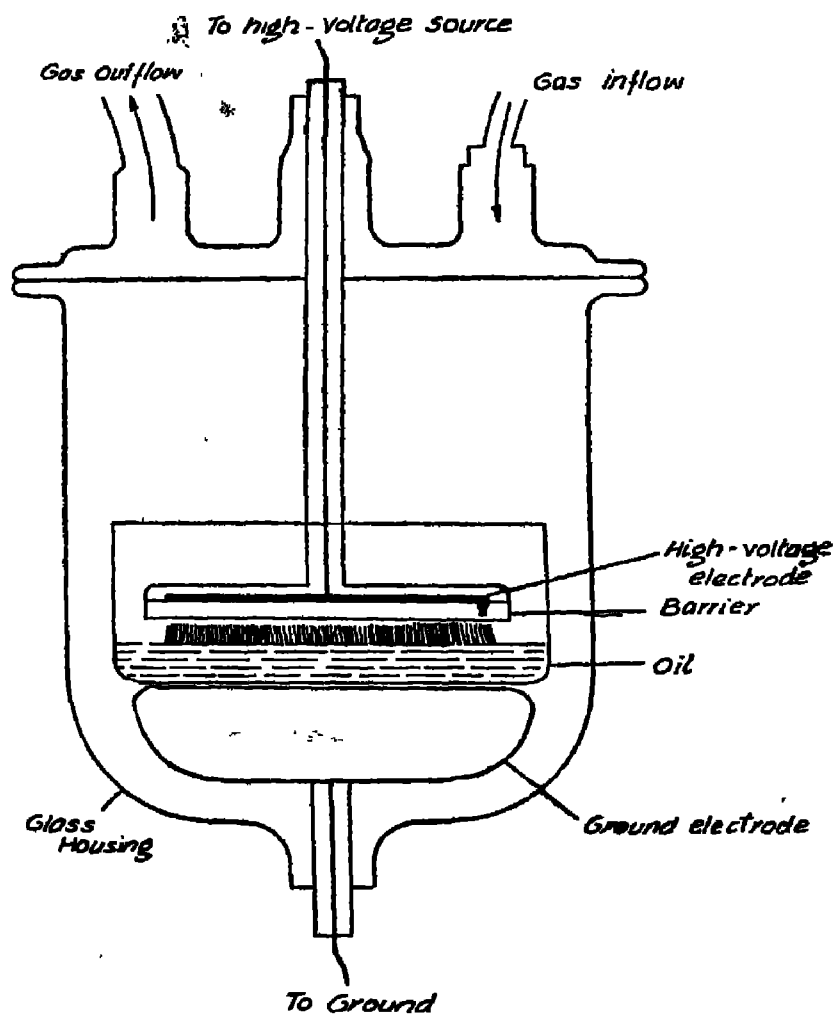


FIG. 2 Liquid Gas Reactor

expensive process. With the use of corona at atmospheric pressure, it was possible to prepare high octane gasoline from coal. For this, a rotating disc reactor, in which the disc carries a film of coal slurry or tar up into the corona zone where it is cracked by the electrons (Fig. 3), is used. One difficulty with coal is its condensed ring molecular structure which is able to absorb a great deal of electrical energy

and, instead of cracking, gives back the energy as heat.

Probably the same principle works in case of oils used as moderators in some nuclear reactors. These oils are effective in absorbing energy. In these days of high petroleum cost, the conversion of coal into liquid fuel by corona technique may prove to be an economic possibility. □

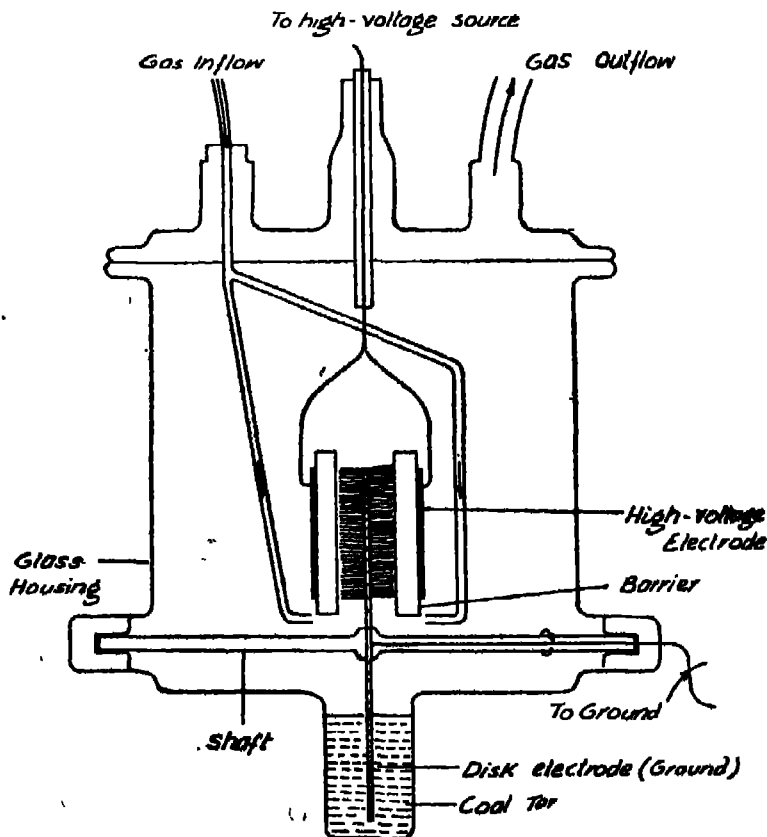


FIG. 3. Rotating Disc Cell



# Raman Effect and its Applications

B. K. SHARMA

Department of Physics  
Regional College of Education  
Bhubaneswar

THE PHENOMENON of scattering of light from physical objects has been a significant field of speculation since the beginning of the present century. When light passes through a 'transparent' substance, a solid, a liquid or a gas, a small fraction of it is diffusely reflected or 'scattered' in all directions giving rise to Tyndall effect in which the light can be seen from the sides. Rayleigh, assuming the scattering due to individual molecules of size smaller than the wavelength of light, showed that the intensity of the scattered light is inversely proportional to the fourth power of the wavelength. The blue colour of the sky and the tobacco smoke and the red of sunset are the familiar examples in nature. These effects result from 'fluctuation of density' of a heterogeneous medium because the distribution of molecules in air is far from uniform. When solar rays pass through atmosphere the heterogeneous medium scatters the blue colour more

than the red giving to the sky its familiar colour. When the rays pass through the thicker layer of air, the reddening during the sunset is observed. Were these density fluctuations not present, the sky would always look completely dark and then the stars could be seen during the day hours as well.

During the course of subsequent researches on the scattering of light, careful analysis revealed the existence of two types of scattering, namely, the coherent scattering like Rayleigh's and Tyndall's—in which no frequency change is observed as there exists a definite phase relationship between the incident and the scattered beam and the other is incoherent scattering, like Raman's—in which the scattering elements are totally independent so as to produce random change in phases and hence frequency between various parts of the scattered beam.

In 1928, C. V. Raman and his collaborators with their persistent efforts, extensive studies and careful investigations on light scattering by a pure, dust-free transparent chemical substance, observed that a small fraction of the light is scattered by molecules in directions other than that of the incident light thereby suffering a change-in-frequency and a random alternation in phase. The Raman lines observed in the scattered light contain frequencies both smaller corresponding to the so-called stoke's line as well as greater frequencies of the Anti-Stoke's lines than the unmodified frequency of the incident light. This effect, though predicted theoretically by A. Smekal in 1923, was first experimentally observed by Raman, hence the name Raman Effect is given to such phenomenon.

Raman effect, an optical analogue of Compton Effect (frequency change in X-rays scattered by electrons), is very feeble, and therefore,

was difficult to observe. It was just because of its low intensity that this effect could not be discovered until 1928; Its intensity is roughly ten-thousandth or still less than that corresponding to Rayleigh's scattering in liquids and still smaller in gases. Taking large samples in bulk and using intense irradiation the effect becomes visible.

Raman lines are found to have the following features.

- (i) They possess frequencies both greater and less than that of the incident line.
- (ii) They are characteristic of the particular mole species.
- (iii) Their intensity is proportional to the number of scattering molecules present.
- (iv) Their frequency shifts in the scattered spectrum are chiefly determined by the nature of the scatterer rather than the frequencies themselves.
- (v) They are strongly polarized.
- (vi) They are either actual infrared frequencies in the absorption spectrum of the scattering substance or differences in such frequencies.

The mechanism of Raman scattering can be easily understood by treating the incident monochromatic light as consisting of photons (having energy proportional to frequency) colliding with the molecules of the scattering substance. Because of a large number of elastic collisions, the photons are scattered

with no change in frequency. While due to certain inelastic collisions, the molecules absorb energy from or emit it to the photons, which are thereby scattered with diminished or enhanced energy, hence, with lower or higher frequency as shown in Fig. 1. The frequency is modified according to:  $\nu' = \nu \pm \nu_m$ , where,  $\nu$  and  $\nu'$  are the frequencies of the incident and scattered photons while  $\nu_m$  is the frequency of some conceivable emission or absorption line characteristic of the scattering molecules. The spacing of Raman lines are symmetrical about the main line.

It is to be noted that the Stoke's lines are more intense and numerous than the so-called anti-Stoke's lines as the former are caused by low energy photons. The anti-Stoke's lines, having higher frequencies, correspond to high energy photons. This energy is supplied by the molecules themselves. The temperature of the scattering moles affect the intensity of Raman lines appreciably. The intensity ratio of an anti-Stoke's line to a Stoke's line is approximately equal to the ratio of number of energy-emitting molecules to the number of energy-absorbing molecules from the source of light. At absolute zero, there is neither vibrational nor rotational energy available to the molecules and hence, inelastic collisions are not possible.

The experimental arrangement used by Raman and later on modified by Wood (Fig. 2) for observing the effect utilizes an intense source of light S (Mercury arc) surrounded by reflector R to increase the light intensity. Obviously, every incident line produces its own Raman lines but the confusion is avoided by using filter F which renders the single frequency (normally blue line of Mercury arc spectrum) to pass through it and absorbs all other frequencies. The intense monochromatic light then falls on a dust-free transparent chemical substance under investigation contained in a horn-shaped cylindrical tube T blackened

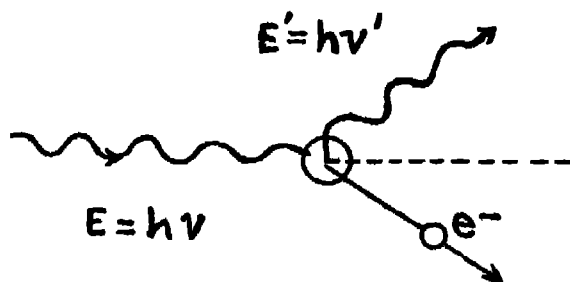


FIG. 1. Photon atom collision

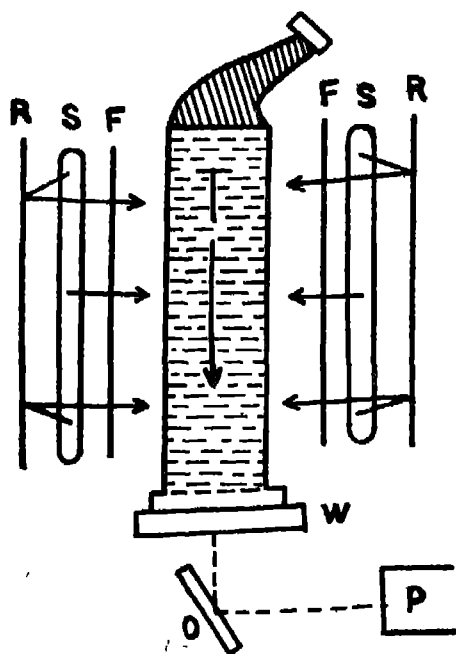


FIG. 2. Arrangement for Raman Effect

outside at one end so as to provide a perfect black background when the scattered light is

viewed through the window W (an optically plane glass plate) at the other end.

Though the Raman scattering is almost uniform in all directions, to avoid the interference of strongly exciting light with the observation of the scattered light, the scattering is studied at right angles to the incoming light beam. The scattered light, after being transmitted through a window W, is examined by means of spectrograph P placed transversely by using suitable optical system "O" which focusses the beam on a photographic plate. In the spectrum so obtained we can observe lines corresponding to Raman frequencies resolved from Rayleigh's scattered exciting frequency. These days, grating spectrographs, photomultiplier tubes and the electronic amplifiers are now available to record Raman spectra automatically, thereby increasing the speed and precision of measurement of intensities of Raman line frequencies. The photoelectrically recorded Raman spectrum is clearly shown in Fig. 3, in which the intensity of the scattered light has been plotted along the vertical direction and the frequency in wave number units along the horizontal direction.

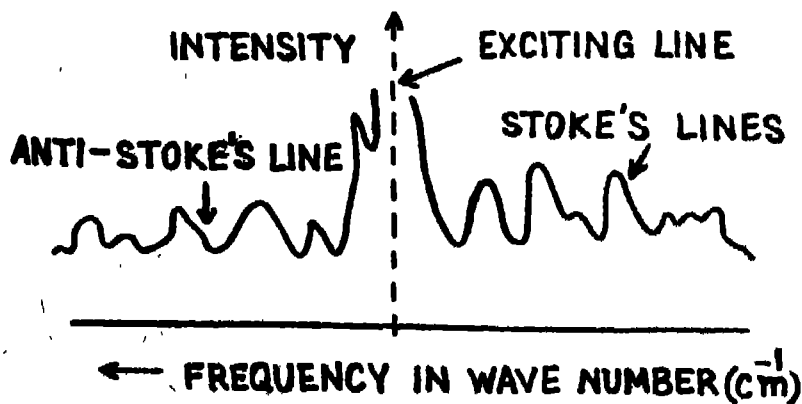


FIG. 3. Typical Raman Effect

Raman effect promises to be of immense use in physics and chemistry and has become an important and powerful tool of investigation in the hands of a researcher for explaining the molecular structure of matter, specially the constitution, number and arrangement, and motion of molecules in various states of matter, the gaseous, liquid and solid. As the spectral lines differ in degree of polarization depending on the symmetry of the scattering species, these observations for analysis and determination of molecular symmetry provide further

evidence on molecular structure. Also, Raman spectra yield informations regarding molecular moment of inertia and the vibrational frequencies. Because of the fact that Raman lines are characteristic of the molecules species and that their intensity is proportional to the number of scattering molecules, Raman spectra are being used in qualitative as well as quantitative analysis. The Raman effect recording apparatus are also being used in the petroleum industry and other various commercial purposes. □

# Teaching of Science in Panjab Schools

## A Critical Survey

H. S. VIRK

Reader, Department of Physics  
Panjabi University  
Patiala

TEACHING OF SCIENCE has been made compulsory in all the schools of Panjab from the current academic session. To assess the problems of this compulsory introduction of science in the curricula of Panjab schools, a survey has been conducted of 35 schools selected from four districts of Panjab State, viz. Patiala, Sangrur, Ludhiana and Faridkot. The survey includes 23 high schools, 7 higher secondary and 5 English-medium model and public schools. Most of the schools belong to the rural areas.

The data obtained in this survey has been tabulated and given in the Appendix. It has been analysed to assess the various problems faced by students and teachers. Furthermore, the data reveal the discriminatory role played by English-medium model schools and the wedge they drive between the rural and urban areas. The conclusions drawn are being enumerated below.

### 1. *Impact of Compulsory Science Teaching*

Before the introduction of science as a compulsory subject in Panjab schools, the number of students opting for science was relatively small as compared to the number in other states. At college and university level this picture is still more gloomy. Whereas in other states, e.g. Tamil Nadu, Kerala or Bengal, the percentage of students opting for science subjects amount to 75 per cent, which is even below 25 per cent in Panjab. Though this percentage is going down in almost all the other states yet this decrease is so sudden in Panjab that most of the colleges consider it uneconomical to run science courses if the present circumstances persist.

The Panjab Government has taken a timely measure in introducing science as a compulsory subject in all the schools up to the matriculation level. This has more than doubled the number of students studying science in schools. This will certainly increase the percentage of science students in colleges and universities.

### 2. *Medium of Instruction*

The survey reveals an interesting aspect regarding the medium of instruction for science subjects in Panjab schools. The percentages of science students opting for Panjabi as medium of instruction in Classes IX, X and XI are 97 per cent, 93 per cent and 1 per cent respectively. This clearly indicates that the majority of students opt for Panjabi (mother-tongue) medium up to matriculation level, whereas few opt for English and Hindi media. But in Class XI (final year higher secondary) as well as in the pre-university class in colleges almost all the students study science in the English medium. This is an enigma. Those students who have studied for two years in the Panjabi medium in schools

are made to switch over to the English medium in the final year. This impedes the progress in the learning as well as teaching of science. Let us once for all decide about the medium of instruction at the school level—"English or mother-tongue?"

All the linguists are of the opinion that for any discipline, original thinking and concepts can be developed only if the medium of instruction is mother-tongue. Even the late Professor Satyen Bose (National Professor of Physics) once said: "If a scientist cannot impart an intricate problem of his field to his students in his mother-tongue, it is not *because he does not know his mother-tongue* but *because he does not know his subject*." It is obvious to draw this conclusion when we know that all the countries leading in science and technology impart instructions to the students in their mother-tongue. Most of the problems in teaching of science will disappear if the government and the universities resolve once for all the problem of the medium of instruction.

### 3. Training of Science Teachers

It has been observed that most of the teachers at the high school level are mere B.Sc's who have obtained their science education through the medium of English. After their recruitment as science teachers they are required to teach in the Panjabi medium. This switch-over proves to be a big handicap. The crux of the problem is that some of the teachers do not even know the basic principles of the language in which they are required to teach science.

### 4. Textbooks in Science

The vernacular textbooks prescribed for science subjects also add to the confusion

prevailing in the teaching of science. As different authors use technical glossary of their own the books written on the same subject differ in different versions. There should be standard textbooks as those produced by NCERT and only those versions in the regional languages should be prescribed in the different states.

### 5. Laboratories and Other Facilities

Teaching of science will be only useful if there are well equipped science laboratories and small museums in the schools. As most of the schools surveyed belong to the rural area, there are little facilities for teaching of science through practical classes. Even the science teachers are averse to impart laboratory training because of their heavy workload and bureaucratic bottlenecks involved in the purchase of science equipment. The rural schools also suffer from lack of trained and efficient staff as compared to their counterparts in the urban areas.

### 6. Model and Public Schools

The English-medium model and public schools have an advantage so far as teaching and laboratory facilities are concerned. The rural areas should not be discriminated against when opening such schools.

These schools are a legacy of the British Raj when they used to serve the cause of the Indian nobility and the Raj. The newly started government model schools are bound to become their prototypes. The survey reveals that they cater largely to the students of the so-called 'nouveau riche'. Hence their very existence is contradictory to the declared aims of education in a democratic society. □

# APPENDIX

## TABLE 1

### HIGH SCHOOLS

<i>S.No.</i>	<i>Name of the School</i>	<i>District</i>	<i>Number of Students Studying Science</i> <i>Class IX Class X</i>		<i>Medium of Instruction</i> <i>Class IX Class X</i>		<i>Science Teacher's Qualifications</i>
1.	Govt. Girls High School Rajpura Town	Patiala	167	19	Panjabi	Panjabi	B.Sc.
2.	Govt. High School, Rajpura	—do—	138	44	—do—	—do—	—do—
3.	Sh. K.K. High School Rajpura	—do—	40	35	Hindi	Hindi	—do—
4.	Govt. High School Nagawanha	—do—	60	32	Panjabi	Panjabi	—do—
5.	Govt. High School, Ajrour	—do—	150	30	—do—	—do—	—do—
6.	Govt. High School Machhigan	—do—	140	51	—do—	—do—	—do—
7.	Govt. High School Harpalpur	—do—	90	30	—do—	—do—	—do—
8.	Govt. High School, Sanaur	—do—	100	90	—do—	—do—	—do—
9.	Govt. High School Rupalheri	—do—	140	70	—do—	—do—	—do—
10.	Govt. High School, Shatrana	—do—	45	25	—do—	—do—	—do—

S.No.	Name of the School	District	Number of Students Studying Science		Medium of Instruction		Science Teacher's Qualifications
			Class IX	Class X	Class IX	Class X	
11.	Govt. High School Dayalpura, Sodhian	—do—	85	55	—do—	—do—	B Sc.
12.	Govt. High School, Halwara	Ludhiana	109	64	—do—	—do—	—do—
13.	Govt. Girls High School Raikot	—do—	117	79	—do—	—do—	—do—
14.	Govt. High School Talwandi Rai Ke	—do—	29	21	—do—	—do—	—do—
15.	Govt. High School Dadhahoor	Sangrur	31	27	Panjabi	Panjabi	—do—
16.	Govt. High School Jalaldiwal	—do—	27	21	—do—	—do—	—do—
17.	Govt. High School, Bangan	—do—	44	12	—do—	—do—	—do—
18.	Govt. High School, Gowara	—do—	35	15	—do—	—do—	—do—
19.	Govt. High School, Badbar	—do—	60	20	—do—	—do—	—do—
20.	Govt. High School, Kaurian	—do—	70	35	—do—	—do—	—do—
21.	Govt. High School, Sanghera	—do—	83	50	—do—	—do—	—do—
22.	Govt. High School Pakhi Kalan	Faridkot	27	21	—do—	—do—	—do—
23.	Govt. High School Jiwanwala	—do—	50	16	—do—	—do—	—do—



TABLE 2

## HIGHER SECONDARY SCHOOLS

S.No.	Name of the School	District	Number of Students Studying Science		Medium of Instruction		Science Teacher's Qualifications		
			Class IX	Class X	Class IX	Class X			
1.	Govt. Hr. Sec. School (N.T.C.) Rajpura Town	Patiala	135	58	5	Panjabi	Panjabi	English	M.Sc.
2.	Janta Hr. Sec School Rajpura	—do—	30	30	15	Hindi	Hindi	—do—	—do—
3.	Govt. Girls Hr. Sec. School, Old Police Lines, Patiala	—do—	160	19	10	English-2 Hindi-10 Panjabi-148	English	—do—	—do—
4.	Dhucial Kh. Hr. Sec. School, Patiala	—do—	98	22	13	Panjabi	Panjabi	—do—	B.Sc.
5.	Govt. Multipurpose Hr. Sec. School, Patiala	—do—	105	75	21	—do—	Panjabi-70 English-5	English-20 Panjabi-1	M.Sc
6.	Govt. Hr. Sec. School Raikot	Ludhiana	121	71	49	—do—	Panjabi	English	M.Sc.
7.	Govt. Girls Hr. Sec. School, Kot Kapura	Faridkot	250	50	8	—do—	—do—	—do—	B.Sc.

# Mini Workshop on a Bicycle

P. K. BHATTACHARYYA  
Workshop Department, NCERT

SOME BASIC hand-tools and simple machine tools are required for developing prototypes, maintaining equipment, making models for hobby centres and even for day-to-day household repairs. Those who like to enjoy the charm of working with their own hands often face the problem of grinding, turning, facing, coil winding, drilling, etc. These are very common operations required for a small job. School boys generally work on light sheet metals and wood (which can be easily fabricated) while making their own models. They also require similar operations to be done on those. Those who are to set up models on electricity (low voltage) will not like to work with torch cells if any other source of electricity is available. This is due to various difficulties with the torch cells. Schools and hobby centres having electricity supply can use motorized units for fabrication works. For a typical rural situations, we then have to think of some mechanically driven implements. For designing school science equipment, we have encouraged the use of common indigenous materials which are

available everywhere. The power, generated at the bicycle pedals, can solve some of those problems nicely. Bicycle is available everywhere. Only some attachments are to be fitted in it to serve the purpose.

## *Power Developed at the Bicycle Pedal*

The average effort that is generally given at the pedal by the cyclist is 15 kg. At moderately high speed, the pedal is rotated at 66 R.P.M. Taking the pedal radius to be 180 mm—

$$\begin{aligned} \text{HP generated} &= \frac{2\pi NT}{75 \times 60} \quad \text{where } N = \text{R.P.M.} \\ &\quad T = \text{Torque in kgm} \\ &= \frac{2\pi \times 66 \times (15 \times 18)}{75 \times 60} \approx 0.24 \text{ (nearly)} \end{aligned}$$

## *Attachment to utilize the Power at the Pedal in Cutting, Grinding, etc.*

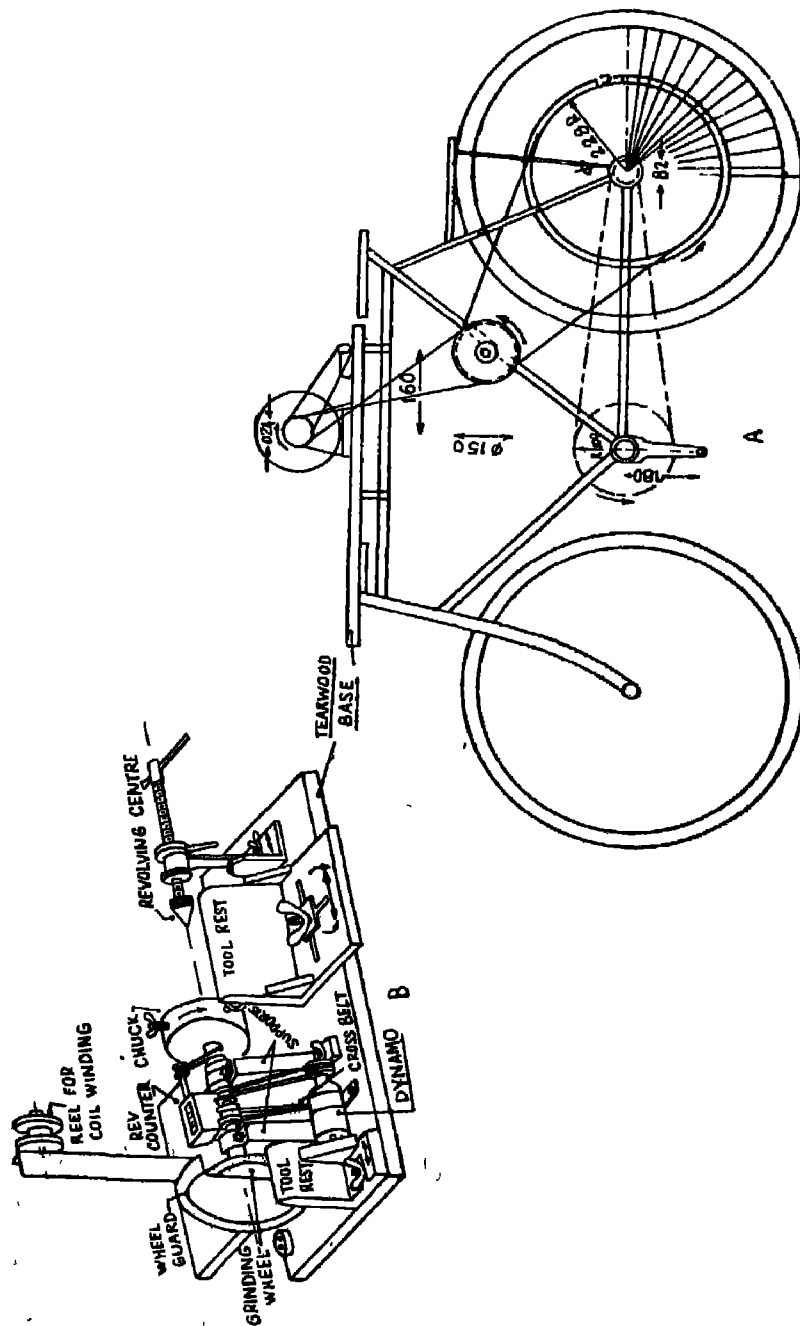
Drawing No. 1 shows the power transmission arrangement. Attempts in arranging the pulleys have been made in such a manner that a very high R.P.M. may be obtained at the chuck. Thus, if the pedal rotates at the 66 R.P.M., the chuck will rotate at—

$$66 \times \frac{100}{41} \times \frac{228}{75} \times \frac{75}{12} = 3058 \text{ R.P.M.}$$

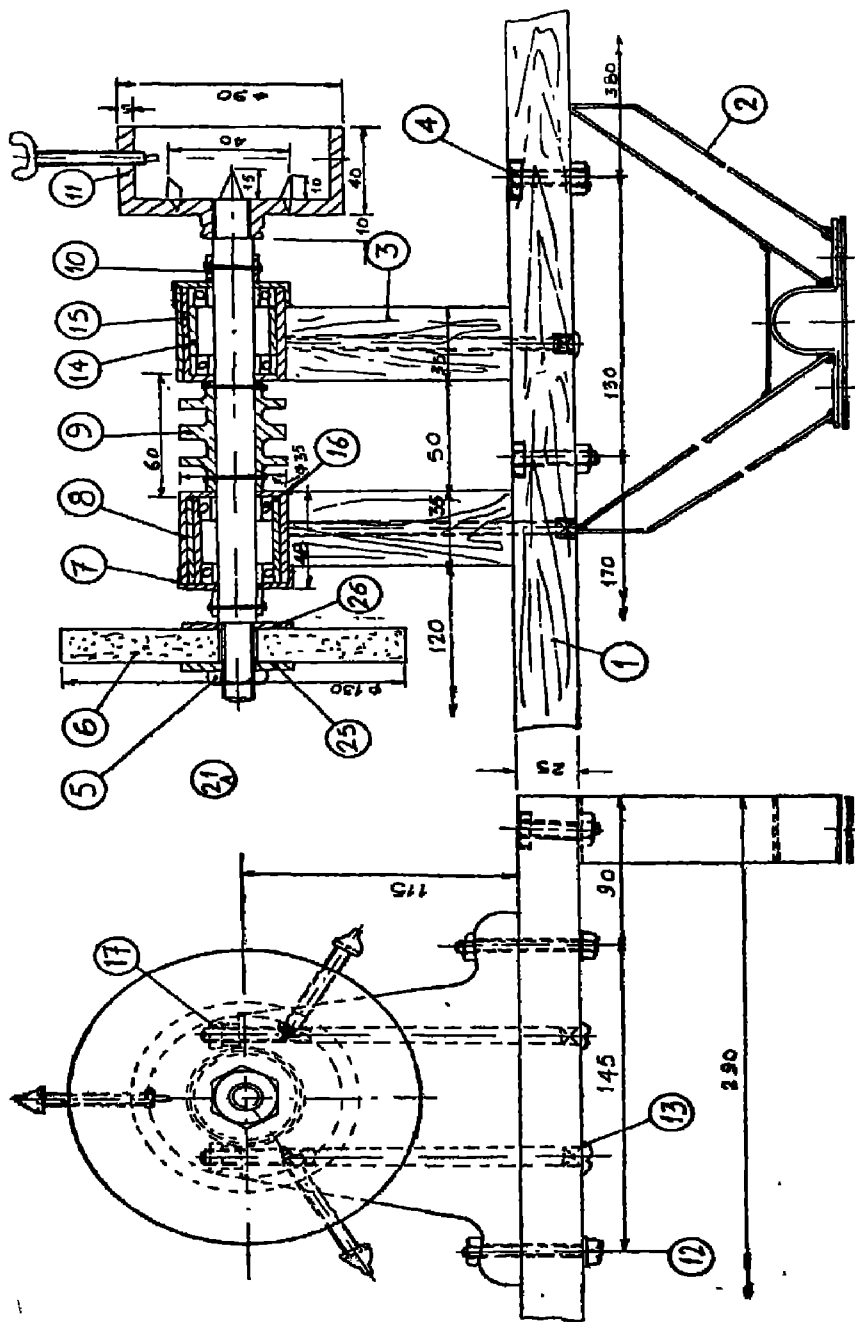
Considering a slip of 5% on each belt the R.P.M. at the chuck will be—2700 R.P.M.

Drawing No. 1 shows that a sheet metal rim of 228mm radius is fitted to the rear wheel. This rim is fixed in position with the help of thin wires wrapped around the spokes. The compound pulley at the frame is rotated by the rim through the open belt and the 24 mm diameter pulley on the main spindle is rotated by the compound pulley through cross belt.

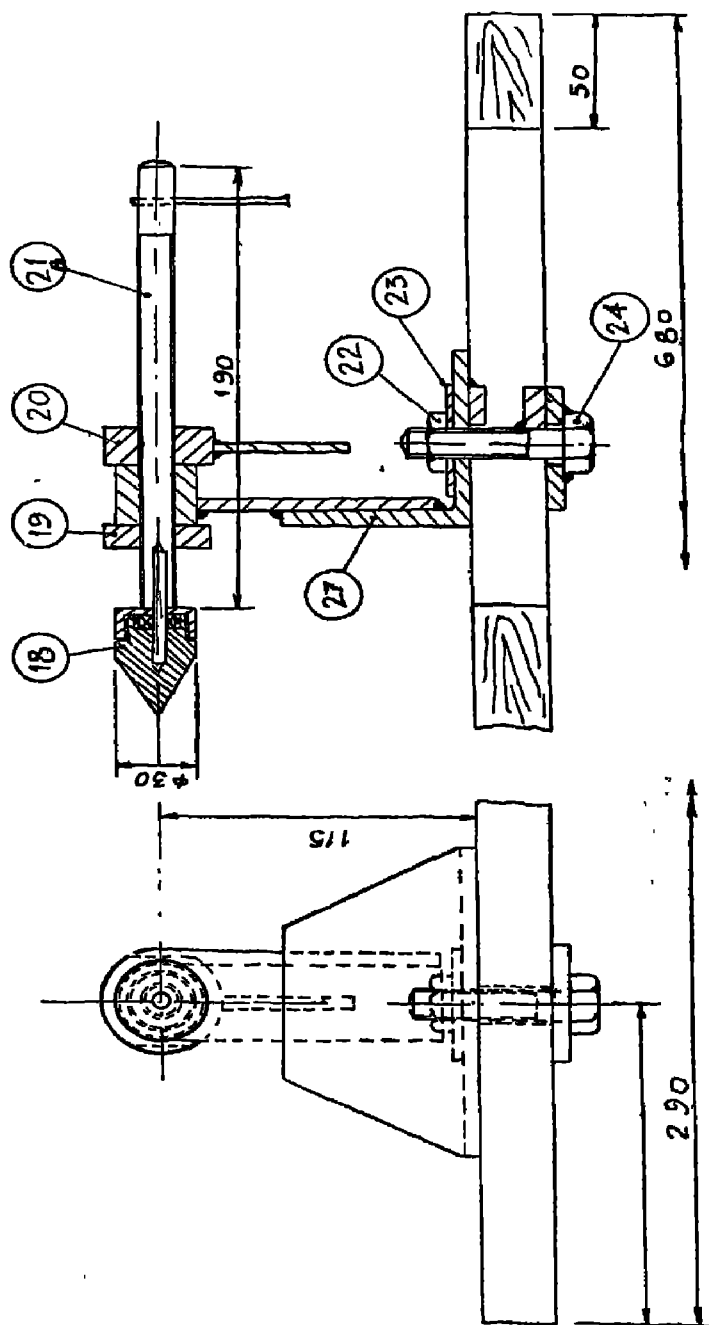
Two supports are to be fitted on the horizontal pipe of the bicycle frame. On these supports, a teak-wood base with the chuck-tail stock assembly will be mounted. Drawing No. 1 shows (from the left): plug point, the



Drawing No. 1



Drawing No. 2



Drawing No. 3

ITEM	DESCRIPTION	MAT.	NO. OFF	REMARK
17	NUT	M.S.	2	PLATED
16	BALL BEARING	M.S.	2	NO. 6002 $\phi$ 15
15	BUSH	M.S.	2	
14	SPACER	M.S.	2	
13	STUD M6X150	M.S.	4	PLATED
12	NUT BOLT M6X50	M.S.	4	
11	CHUCK	C.I.	1	
10	BUSH	M.S.	2	
9	PULLEY	M.S.	1	
8	BRACKET	M.S.	2	BLACK PAINT
7	COVER	M.S.	2	PLATED
6	GRINDING WHEEL		1	$\phi$ 150/120 X 20
5	NUT M12	M.S.	1	PLATED
4	NUT & BOLT M6X30	M.S.	4	PLATED
3	SUPPORT BLOCK	WOOD	2	GREEN PAINT
2	BRACKET	M.S.	2	BLACK PAINT
1	BASE	TEAK WOOD	1	GREEN PAINT

Drawing No. 4—Bill of Materials

grinding wheel with guard and tool rest, wooden supports for the spindle, revolution counter for coil-winding, cross belt connection to the compound pulley, open belt connection to the dynamo, the chuck, the tool rest for turning, facing, etc. and the tail stock with the revolving centre. The two tool rests can be adjusted as shown and the tail-stock can be moved back and forth for long and short jobs. The details of the chuck, the tail stock, the bill of materials can be seen in Drawing Nos. 2, 3, 4 respectively.

### *Operation*

The arrangement is suitable for wood-work. On one side, the log is to be held in the chuck either on the centre and two pins (Drawing No. 2) or by screwing in the three screws depending on the size of the log; on the other side, the revolving centre will be pressed on to the log by means of screw and nut (Drawing No. 3). The cycle is to be supported on its stand, so that the rear wheel is lifted from the ground. The tool rest is to be adjusted to the desired position and fixed in this position by the fly-nut. First few pedalls will overcome the inertia of the whole system and after 15-20 pedallings, the fly-wheel action of the chuck will be observed. The operator will hold the tool with both

hands, rest it on the tool-rest and advance towards the job held between the centres. The grinding operation is comparatively easier. While winding coils, the spindle is to be rotated at a lower speed and the revolution will be read from the revolution counter. For all these operations, the operator will sit on the carrier and pedal with his legs.

The dynamo will produce electricity. While peddling, if a bulb is connected to the plug-point on the base, it will glow brighter with higher speed of peddling.

### *Salient Features*

- (a) All the attachments are detachable.
- (b) All the parts are easily repairable/replaceable.
- (c) The extra pulley on the main spindle may be utilized for transmitting this motion to any desired equipment set-up.

### *Understanding Mechanics*

The power transmission can be a lesson for the students. This can also be accompanied by calculations of mechanical advantage and velocity ratio, etc. This simple and indigenous arrangement may motivate many to think on similar lines and in addition help develop basic skills in handling machine tools. □

## Ivan Pavlov

*"Leave me alone. A real tragedy has occurred. All my butterflies are dead and you worry over a silly trifle"—this was how a devoted scientist replied to his wife when she grumbled over the rejection of her husband's candidature for a university position which, went in favour of a less talented person. These utterances of Ivan Petrovitch Pavlov, 'an experimenter from tip to toe', is the evidence of his unfettered dedication to science. This Russian genius is regarded as the greatest experimental physiologist.*

Son of an orthodox priest, Pavlov entered a seminary after graduation from the grade school to study theology. Here he became interested in the natural sciences, specially, biology. Later he studied medicine to become an experimental physiologist. Even in his early childhood he showed a quick and brilliant mind, fierce competitive spirit and the determination to excel in all the courses he pursued.

Pavlov's first paper on nervous control of the pancreas was published in 1878. In 1883 he received his M.D. for the discovery of the nervous regulation of the heart muscle contraction. Subsequently, he studied the digestive physiology, which brought him the Nobel Prize for medicine in 1904. But his world wide fame is owing to his work on the conditioned reflex whereby he showed that dogs could be conditioned to respond in a specific way to a meaningless stimulus (sound or light) of a particular kind. Pavlov used techniques of conditioned reflex to enquire into psychological phenomena, which eventually led him to psychiatry and conditioning of the behaviour of animals including man.

Endowed with all the qualities of an ideal experimental scientist—grim determination, infinite patience, open mind and experimental skill—he is regarded as one of the most controversial scientific personalities in history. Through out his life, Pavlov was subject to temperamental outbursts. His vitriolic comments on scientific as well as socio-political issues often provoked bitterness. But later he would calm down to weigh the evidences and would even acknowledge defeat if facts demanded. "Of course they are right. We have no exclusive patent on truth"—once he pronounced to draw the curtain in one such controversy.

He held high position in the Czarist Russia, enjoyed unprecedented honour and support from the Soviet Government and received ovation and acclaim from the world outside. Way back in 1936, Ivan Pavlov addressed the academic youth of his country. We are reproducing that address below. We are convinced that what Pavlov said forty years ago is still valid for the students and teachers of science today.



1849 - 1936

What shall I wish for the young students of my country? First of all, sequence, consequence and again consequence. In gaining knowledge you must accustom yourself to the strictest sequence. You must be familiar with the very groundwork of science before you try to climb the heights. Never start on the "next" before you have mastered the "previous". Do not try to conceal the shortcomings of your knowledge by guesses and hypotheses. Accustom yourself to the roughest and simplest scientific tools. Perfect as the wing of a bird may be, it will never enable the bird to fly if unsupported by the air. Facts are the air of science. Without them the man of science can never rise. Without them your theories are vain surmises. But while you are studying, observing, experimenting, do not remain content with the surface of things. Do not become a mere recorder of facts, but try to penetrate the mystery of their origin. Seek obstinately for the laws that govern them. And then—modesty. Never think you know all. Though others may flatter you, retain the courage to say, "I am ignorant." Never be proud. And lastly, science must be your passion. Remember that science claims a man's whole life. Had he two lives they would not suffice. Science demands an undivided allegiance from its followers. In your work and in your research there must always be passion.

—1936



# Albert Einstein

Albert Einstein, the doyen of humanists is considered as the greatest scientist of this century. He is ranked with the great geniuses like Copernicus, Galileo and Newton. Far from being a child prodigy and unable to adapt himself to the teaching methods and school system of his time, he was a poor student except in mathematics where his original thinking often stultified his teachers.

Only at the age of twenty-six as an ordinary employee of the Swiss Patent Office at Berne, he published his first group of papers including those on Special Theory of Relativity in 1905. His General Theory of Relativity was published in 1916. He got the Nobel Prize for physics in 1921. His Unified Field Theory was published in 1950. His works, explaining the causal relations of the natural phenomena had given a new dimension to modern physics and changed the very basis and magnitude of scientific thinking. His conclusion that mass (matter) could be transformed into energy and vice versa had exploded the long held view that matter can neither be created nor destroyed. This had laid the foundation of the utilization of nuclear energy for war and peace.

A German Jew by birth, turned Swiss, Einstein in his tortuous career had suffered poverty, state imposed separation from his wife, intellectual neglect and banishment from Hitler's Germany. Also in his lifetime, he was hailed as the greatest scientist of his age. He took all these with equal ease and grace.

Essentially a simple, saintly person, this great scientist was equally drawn to art and music, a trend derived from his maternal lineage. He was an exponent of Mozart on violin.

Courageous and kind, Einstein always opposed war and oppression and ardently advocated disarmament and world government.

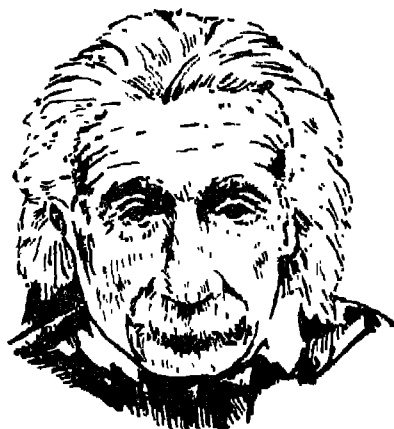
His deep concern for humanity came up again and again whenever he spoke or participated in any scientific discussion. The address he delivered at the California Institute of Technology in 1938 is reproduced below. The readers will not miss a note of grave apprehension that man may hurt himself if his scientific knowledge is not tempered with a consideration for the humanity. This apprehension was borne out by the ravages of the Second World War which started in 1939.

## MY DEAR YOUNG FRIENDS,

I am glad to see you before me, a flourishing band of young people who have chosen applied science as a profession.

I could sing a hymn of praise with the refrain of the splendid progress in applied science that we have already made, and the enormous further progress that you will bring about. We are indeed in the era and also in the native land of applied science.

But it lies far from my thought to speak in this way. Much more, I am reminded in this



1879 - 1955

connection of the young man who had married a not very attractive wife and was asked whether or not he was happy. He answered thus: "If I wished to speak the truth, then I would have to lie."

Why does this magnificent applied science, which saves work and makes life easier, bring us so little happiness? The simple answer runs—because we have not yet learned to make a sensible use of it.

In war, it serves that we may poison and mutilate each other. In peace, it has made our lives hurried and uncertain. Instead of freeing us in great measure from spiritually exhausting labour, it has made men into slaves of machinery, who for the most part complete their monotonous long day's work with disgust, and must continually tremble for their poor rations.

You will be thinking that the old man sings an ugly song. I do it, however, with a good purpose, in order to point out a consequence.

It is not enough that you should understand about applied science in order that your work may increase man's blessings. Concern for man himself and his fate must always from the chief interest of all technical endeavours, concern, for the great unsolved problems of the organization of labour and the distribution of goods—in order that the creations of our mind shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations.

—1938 □

# An Inexpensive Rheostat

**A. C. CHADHA**

P.G.T. (Physics)  
G.B. Higher Secondary School  
Seema Puri, Delhi

A RHEOSTAT is an instrument used to change resistance in an electric circuit. It is an essential item of every school or college physics laboratory. It is used in almost all experiments

based on current electricity. Vast majority of our educational institutions, specially, the schools with limited funds find it difficult to provide adequate number of rheostat for experiments and demonstration work. I have devised a low cost rheostat with easy available, inexpensive material which can be constructed easily by my fellow teachers. I have tried out the instrument in my class for several years without any difficulty.

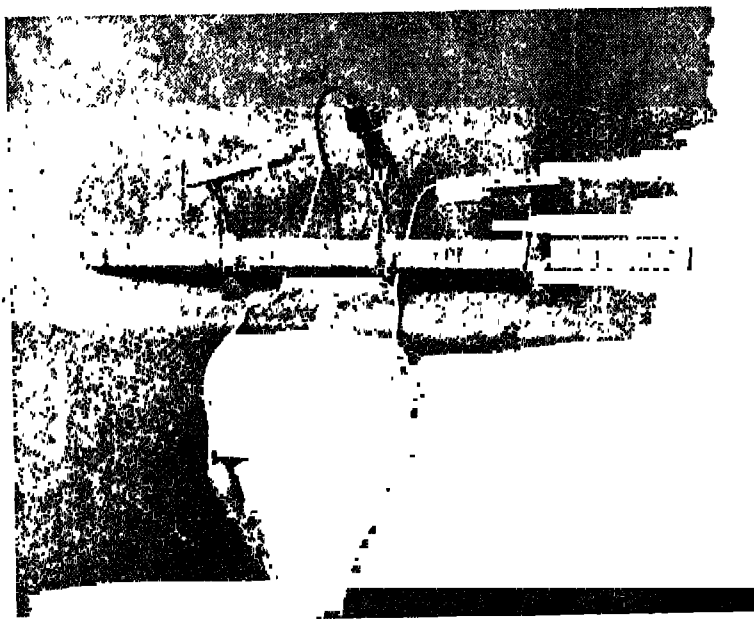
**Construction of the Rheostat (variable resistance type)**

*Apparatus Required*

A condemned piece of laboratory scale (30 cm to 40 cm  $\times$  2.5 cm  $\times$  0.4 cm); resistance wire, 3 burette clips (Pinch cocks); 2 crocodile clips.

*Method*

Take the above mentioned piece of scale. Cut it into two pieces lengthwise. Take one of the pieces and with the help of a sand paper or file make the cut surface smoother. With



An inexpensive rheostat

the help of a triangular file make scratches 2 mm. to 3 mm. apart and 1 mm. deep all along the thickness sides of the scale (on both sides). Fix one end of the resistance wire once the scale every time passing it through the scratch, in such a way that two consecutive turns don't touch each other. The other end of the wire is tried on the other end of the scale in the same way.

Three burette clips (pinch corks) are attached to the resistance wire wrapped scale (rheostat) which can move freely all along the length of the improvised rheostat. The three points of a rheostat are the three burette clips. The connections are taken from these with the help of crocodile clips.

To make a rheostat of the required resistance the length of the resistance wire can be calculated with the help of the following table.

RESISTANCE OF WIRES IN OHMS PER METRE

S.No.	Thickness of wire in m.m.	Thickness in S.W.G.	Manganin	Constantan	Nichrome
1.	0.71	22	1.05	1.23	2.72
2.	0.56	24	1.69	2.00	4.40
3.	0.46	26	2.53	3.00	6.60
4.	0.38	28	3.75	4.40	9.70
5.	0.32	30	5.30	6.30	13.09

#### Modifications

To construct such improvised rheostats on large scale the following modifications are suggested.

- (i) Instead of the wooden scale piece, a piece of unbreakable plastic or ebonite may be used.
- (ii) Nickel plated brass burette clips may be used in order to avoid rusting.
- (iii) A stand may be attached to it.
- (iv) In order to make the rheostat of higher resistance a scale piece of bigger dimensions may be taken and larger size burette clips may be attached.

- (v) An arrangement (provision) may be made over the burette clips for screw (as in crocodile clips) to fix wire (i.e., clips may be designed accordingly).

*Advantages :* The above mentioned rheostat has the following advantages over the usual type of rheostats.

1. Its cost is very low about one rupee as compared to the cost of the usual type of rheostat which is more than Rs. 75/.
2. The articles used are easily available.
3. It is very easy to construct.
4. There is no difficulty in using it.
5. Any unserviceable part of the inexpensive rheostat can be easily replaced.
6. Its working is more satisfactory because its contacts are better than the costly rheostats. The central contact becomes often loose in the costly rheostats and thus it becomes unserviceable.

#### Saving

Five to ten rheostats each costing more than Rs. 75/- are required in the Physics lab. of a higher secondary school and lakhs of Rupees can be saved if the concerned authorities recommend the above mentioned rheostat. The saving will be still more in the coming years as science has become compulsory up to Class X.

This rheostat can be supplied in Class VIII Physics Kit prepared by the NCERT. ☐

# Some Arithmetic Tables

S. RAMASWAMI IYENGAR

Retd. Headmaster

No. 9, Labour Colony, Guindy, Madras

THERE ARE no proper aids or ready to refer tables to teach division as we have in case of addition, subtraction or multiplication. I have evolved these following tables to help the children in Primary Schools to do the division sums without any difficulty or embarrassment. Hundreds of children will be able to work out addition, subtraction, multiplication or division, quickly and correctly.

## Key to the Tables

- If the table number is added to any number in that table the preceding number above is the *total*.
- If the table number is subtracted from any number in that table the succeeding member below is the *difference*.
- If the basic numbers 1 to 12 in the first column is multiplied by the table number, the number adjacent to the basic number is the *product*.
- If the number in the table is divided by the table number the first number, in the same row is the *quotient* (Q). The top most number in the same column is the *remainder* (R).

## Two 2 Elements

	0	1	2
0 X	0	1	
1	2	3	
2	4	5	
3	6	7	↓
4	8	9	+
5	10	11	2
6	12	13	
7	14	15	
8	16	17	2
9	18	19	1
10	20	21	↑
11	22	23	
12	24	25	

	Q	R
$13 \div 2 =$	6	1
$22 \div 2 =$	11	0

## Three 3 Elements

	0	1	2	3
0 X	0	1	2	
1	3	4	5	↓
2	6	7	8	+
3	9	10	11	3
4	12	13	14	
5	15	16	17	
6	18	19	20	3
7	21	22	23	1
8	24	25	26	↑
9	27	28	29	
10	30	31	32	
11	33	34	35	
12	36	37	38	

	Q	R
$20 \div 3 =$	6	2
$31 \div 3 =$	10	1

Four						<div>4</div>	Elements						
4	0	1	2	3	4		5	0	1	2	3	4	
0	X 0	1	2	3			0	X 0	1	2	3	4	
1	4	5	6	7			1	5	6	7	8	9	
2	8	9	10	11	↓		2	10	11	12	13	14	
3	12	13	14	15	↑		3	15	16	17	18	19	
4	16	17	18	19	4		4	20	21	22	23	24	
5	20	21	22	23			5	25	26	27	28	29	
6	24	25	26	27			6	30	31	32	33	34	
7	28	29	30	31			7	35	36	37	38	39	
8	32	33	34	35	4		8	40	41	42	43	44	
9	36	37	38	39			9	45	46	47	48	49	
10	40	41	42	43	↑		10	50	51	52	53	54	
11	44	45	46	47			11	55	56	57	58	59	
12	48	49	50	51			12	60	61	62	63	64	
						Q	R						
29 ÷ 4						7	1						
39 ÷ 4						9	3						

Six <span style="border: 1px solid black; padding: 0 2px;">6</span> Elements						
6	0	1	2	3	4	5
0	X 0	1	2	3	4	5
1	6	7	8	9	10	11
2	12	13	14	15	16	17
3	18	19	20	21	22	23
4	24	25	26	27	28	29
5	30	31	32	33	34	35
6	36	37	38	39	40	41
7	42	43	44	45	46	47
8	48	49	50	51	52	53
9	54	55	56	57	58	59
10	60	61	62	63	64	65
11	66	67	68	69	70	71
12	72	73	74	75	76	77

Seven		7							Elements	
		0	1	2	3	4	5	6	7	
0	X	0	1	2	3	4	5	6		
1		7	8	9	10	11	12	13		↓
2		14	15	16	17	18	19	20		+
3		21	22	23	24	25	26	27		7
4		28	29	30	31	32	33	34		
5		35	36	37	38	39	40	41		
6		42	43	44	45	46	47	48		
7		49	50	51	52	53	54	55		7
8		56	57	58	59	60	61	62		↓
9		63	64	65	66	67	68	69		↑
10		70	71	72	73	74	75	76		
11		77	78	79	80	81	82	83		
12		84	85	86	87	88	89	90		

Eight		8								Elements	
		0	1	2	3	4	5	6	7	8	
0	X	0	1	2	3	4	5	6	7		
1		8	9	10	11	12	13	14	15		
2		16	17	18	19	20	21	22	23		
3		24	25	26	27	28	29	30	31		↓
4		32	33	34	35	36	37	38	39		+
5		40	41	42	43	44	45	46	47		8
6		48	49	50	51	52	53	54	55		
7		56	57	58	59	60	61	62	63		
8		64	65	66	67	68	69	70	71		
9		72	73	74	75	76	77	78	79		8
10		80	81	82	83	84	85	86	87		↓
11		88	89	90	91	92	93	94	95		↑
12		96	97	98	99	100	101	102	103		

$$\begin{array}{rcl}
 & & Q \\
 86 \div 8 & = & 10 \\
 100 \div 8 & = & 12
 \end{array}
 \begin{array}{rcl}
 & & R \\
 & & 6 \\
 & & 4
 \end{array}$$

Nine

**9**

Elements

	0	1	2	3	4	5	6	7	8	9
0 X	0	1	2	3	4	5	6	7	8	
1	9	10	11	12	13	14	15	16	17	
2	18	19	20	21	22	23	24	25	26	
3	27	28	29	30	31	32	33	34	35	↓
4	36	37	38	39	40	41	42	43	44	+
5	45	46	47	48	49	50	51	52	53	9
6	54	55	56	57	58	59	60	61	62	
7	63	64	65	66	67	68	69	70	71	
8	72	73	74	75	76	77	78	79	80	9
9	81	82	83	84	85	86	87	88	89	↑
10	90	91	92	93	94	95	96	97	98	
11	99	100	101	102	103	104	105	106	107	
12	108	109	110	111	112	113	114	115	116	

Ten

**10**

Element

	0	1	2	3	4	5	6	7	8	9	10
0 X	0	1	2	3	4	5	6	7	8	9	
1	10	11	12	13	14	15	16	17	18	19	
2	20	21	22	23	24	25	26	27	28	29	
3	30	31	32	33	34	35	36	37	38	39	↓
4	40	41	42	43	44	45	46	47	48	49	+
5	50	51	52	53	54	55	56	57	58	59	
6	60	61	62	63	64	65	66	67	68	69	
7	70	71	72	73	74	75	76	77	78	79	
8	80	81	82	83	84	85	86	87	88	89	
9	90	91	92	93	94	95	96	97	98	99	10
10	100	101	102	103	104	105	106	107	108	109	↑
11	110	111	112	113	114	115	116	117	118	119	
12	120	121	122	123	124	125	126	127	128	129	

Q R

$$109 \div 10 = 10 \quad 9$$

$$56 \div 10 = 5 \quad 6$$

## Book Review

*Cosmic Biology*, Minas Ensarian  
Philosophical Library, New York, 1975

NOT TOO frequently do we come across a book depicting a wide view of *life in the universe* in the light of physical phenomena and mathematical analyses. The present book is a "vividly interesting" attempt to integrate the concept of life and organic evolution into the framework of a physical theory. Life is one of the elements of the whole—the universe; it needs to be studied as a function of the external world. But all the questions posed here for discussion need a wider space than a few slim chapters between the covers of this small book. No wonder, then, that it occasionally skips ahead like a film with several reels missing, and topics off the track like hypnotism or other parapsychological phenomena find their place as a kind of dramatic relief. Maybe when scientific propositions are silently mingled with metaphysical fallacies, it is not always easy to be objective.

We have before us some of the oldest and the newest questions—life, its origin and nature and the possibilities of its being present elsewhere in the universe. Oldest because they are some of the earliest of queries; newest because they still remain unanswered. And the answers are not around the corner either.

The author, a reputed physical chemist, goes deep into a series of calculations to find out the possible number of atoms or molecules with respect to the body weight of a man. Well, even a lay man would like to realize that a human being as a biological object is something more than his 100,000,000,000,000 body cells. A comparison, on the other hand, between an automobile or an airport and a living body suffers certain conceptual limitations. An atomistic view of life sounds too archaic today.

Again, the author seeks to define a hypothetical universe which is characterized by the universality of organic evolution. Simple laws of probability would suggest that there may be as many as 800 million planets nurturing life. If life is present elsewhere, it must be subject to an evolutionary process. The universality of organic evolution, in the hypothetical universe, implies that it should be unique in a particular planet depending upon the determining external factors. Life in different planets may not, in fact, should not, be all uniform expressions of matter even within a finite universe.

Are we alone in the universe? Can we hope to communicate with our galactic neighbours?—We are drifted to another question and the most searching question in space research. Aptly has the author said that man's first contact with extraterrestrial intelligent beings will be the most profound single event in the whole history of human race. Man's illusion that he is the centre of the universe may be shattered and lead to a "cultural and social shock with cosmic ramifications".

At this point, one is inclined to note that even today, the study of extraterrestrial civilization is something esoteric. Till now, the scope of biology is not universal and life is known to be only a terrestrial phenomenon.



non. Because our only example of life is the terrestrial one, our ideas of extraterrestrial life and 'civilization' are too narrow and anthropomorphic. Must life be based on carbon chemistry everywhere? Must all extraterrestrial civilizations be carbon copies of ours? Granted that there have been sporadic suggestions of alternate biochemistry, but little serious thought has been given to this issue after Haldane. We cannot possibly conceive of a paralled phenomenon or an analogous picture nor can we visualize a non-anthropomorphic civilization. Whether we should call such a phenomenon 'life' is beside the point (naming will not be a problem); the fact remains that our imagination does not go beyond our experience. Perhaps this is one of our human limitations.

Well, these are some general observations on the subject of extraterrestrial life and civilization, both in this volume and elsewhere. However, in the present book, extraterrestrial civilization is perhaps one of the finest chapters. Here we find Ensanian analysing his thesis into distinct bands of physical, chemical and mathematical spectra, yet all of them bespeak of the essential wholeness of the theme. Visualization of evolutionary phases on the cosmic scale no doubt shows philosophical basis of the scientific superstructure. Let us hope with the author that a civilization superior to ours would one day establish contact with the humanoid civilization. And if we are not too sceptical, then, let us fancy with the author that it will be before A.D. 2000.

A few more words about life on our little planet. The author has posed the question, and has left for us to ponder: does life have a purpose? This is a metaphysical issue and we just cannot arrive at a reasonable conclusion. If we assume that it has an ultimate purpose, in a way we have to take it for granted that its origins were a cosmic necessity. In other words, it was an inevitable consequence

of the evolution of matter, or, why not of the universe itself! If, on the other hand, it does not have any purpose, then the origins of life were a mere chance—life had emerged out of nature's game of roulette.

"The fate of the human race" is an attractive reading. The age-old conflicts between science and religion and the debates on the existence of God, while not being strictly scientific, are pleasant additions. But unfortunately, the author has economized on the uniqueness of the human phase of evolution in his story of life.

Matter and mind have been left ambiguous issues. Human sense organs are not capable of perceiving all the physical forces in his environment, or, to borrow from the author, we are not aware of all the "dimensions" of natural agents that surround us. But certainly the mental organization gradually improved during evolution. The complexity of human mental organization provides new consequential possibilities. Human evolution is a history of more of these possibilities turning into reality.

The author's final interpretation is that it is not the quantity of life that is important but rather the quality. He sums up: "during the *humanoid period* of organic evolution morality will improve and...the end of this eon will find it at its highest level". A robust optimism! That is what many of us would call it, but since the author does not suppress his humanist stand in his views of the human destiny he deserves to be treated from a humanist's angle.

Human evolution, unlike that of any other animal, is heir to two distinct lines of inheritance—one genetic and the other cultural (or technocultural, if you like). Thus, the nature of human culture would equally determine the future of the human evolutionary progress by the transmission of traditions. A fuller realization of human possibilities and a harmonious symbiosis with human environment, secured by sanity, will ensure a prolonged human era,

The course of human destiny will be determined, in other words, by the kind of "integrative, directive and transmissive mechanisms" that we adopt for our restless human societies and for continuity down the generations.

"...Just as individuals must die, so will mankind vanish"—the author's eventual submission however, may not sound anything like a logical conclusion of his own thesis. Even if some of us are inclined towards this view, the author does not support them with his reasons.

The concept of gravitation and antigravitation is a relevant issue. Gravity stimulus, and the consequent geotropic curvature with relation to plant growth have been lucidly discussed, though the phenomenon of diageotropism still remains an enigma. There are thousand and one instances where the relations between gravitation and the living system are well known but the mechanisms behind them are not fully understood.

Going a few steps backward, one very pertinent point could have been brought along with the story of gravitation chemistry. Intensity, or the degree of gravitational force is determined by the size of a planet. This is one of the factors that determine (along with million others) whether or not a particular planet should be able to nurture life. If the planet is too small and its gravitational force too low, it cannot retain its atmosphere. The *dramatis personae*, for the prebiological reactions, would be compelled to leave the scene. If, on the contrary, the planet is too large, the physical state of participating molecules and their altered ion velocities would not, permit the prebiological chemical reactions to take place.

Physical chemistry is the author's own forte and the appendix is a physicist's view of a quadrant mechanical universe. It is related to the chemical events in the  $n$ -dimensional space, representing a unified field theory. We find here, however, a remarkable departure from the contemporary interpretations of some of the thermodynamic principles. We may agree with the author in principle that orderliness of the universe is constantly decreasing, or, in other words, the entropy of the universe is constantly increasing. But few will be convinced of the relationship that has been drawn between the living process and the cosmic entropy. On the other hand, modern physics will not accept that cosmic entropy is ultimately leading to the ether state. Ether is a long discarded nothingness.

A few more words before we close. In any general discussion, some of the technical terms from widely diverse scientific disciplines almost always sound foreign even to a specialist in one particular field. So, the glossary at the end of the book minimizes a general communication gap between the content and the reader. An informed lay man, however, may not be satisfied with the descriptions of *amino acids* or *antimatter* and may disagree with the definition of *amitosis*. A critical reading may further lengthen the list. Besides, such information like 'hibernation of bear' might, again, face severe disapproval of the biologists. □

UTPAL MALLIK

Lecturer, Department of Education  
in Science and Mathematics, NCERT

## Science News

### MAN AND ENVIRONMENT

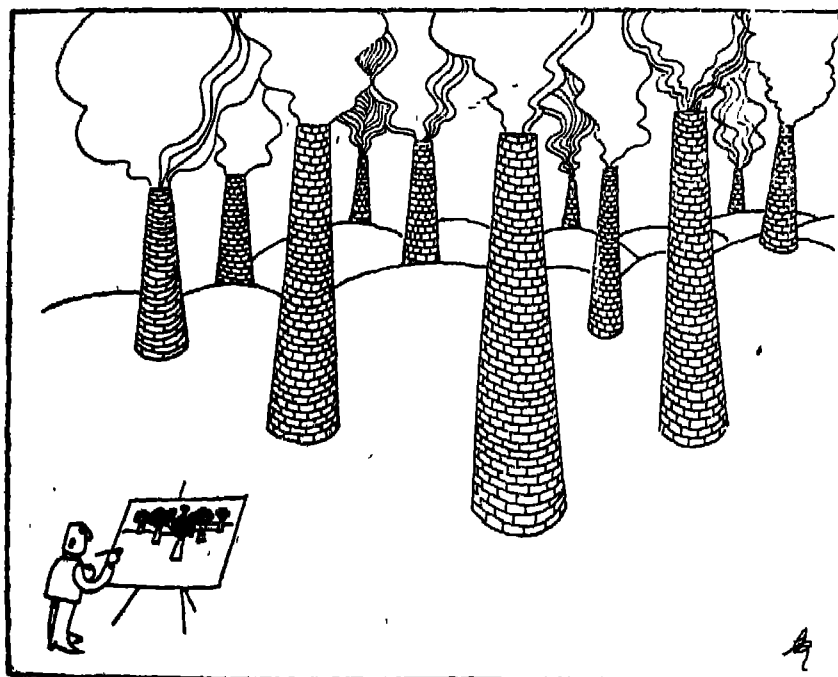
#### Belgrade meeting proclaims environment education charter

SOME 120 educators and government experts from 64 countries, meeting at a ten-day workshop in Belgrade, unanimously adopted a charter for worldwide environmental education.

"The goal of the Belgrade Charter," explained Dr. William Stapp, director of Unesco's environmental education unit, "is to make the people of the world aware of and concerned about the environment....

They must acquire the knowledge and skills, the attitudes and motivations,...to work individually and collectively towards solutions to current problems and also for the prevention of new ones". "Among the most pressing problems facing the earth are environmental pollution, resource depletion and over-population," Dr. Stapp said.

The fact that environmental education—E.E.—is still in its childhood (the term was first used only ten years ago) makes it difficult but all the more necessary to define just what it is. At Belgrade the representatives of the



This drawing by Leo Koralec of Ljubljana and the others illustrating this article were contributions to a competition organized by the Yugoslav Council for the Protection of the Environment. They are reproduced by courtesy of the *Yugoslav Review*.

developed industrialized world, capitalist and socialist, and of the developing countries, poor and rich, laid down these guiding principles for E.E. :

It should "(1) consider the environment in its totality—natural and man-made, ecological, political, economic, technological, social, cultural and aesthetic...(2) be a continuous, lifelong process in and out of school...(3) be interdisciplinary in its approach, (4) emphasize active participation in preventing and solving problems...(5) examine major environmental issues from a world point of view, and (6) consider all development and growth from an environmental perspective."

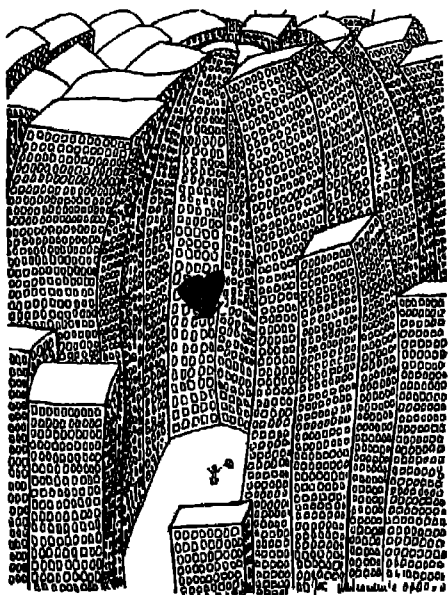
Stapp said that : "As a result of this meeting we have a much clearer idea of what the needs and priorities are and what is actually going on."

He continued : "It is essential when we say 'education' that it be understood we mean the total education system, both formal and

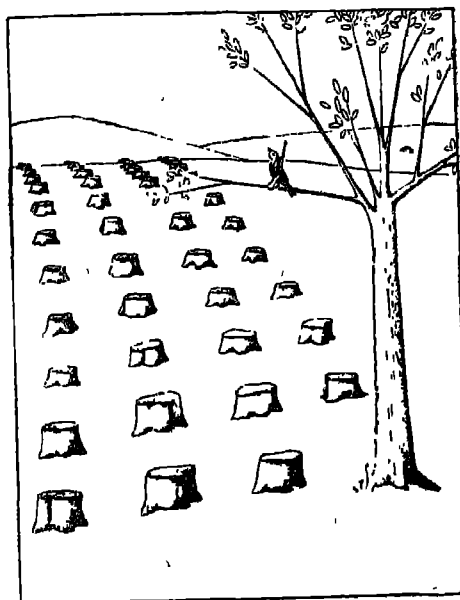
non-formal, in and out of school. Even today, in some countries, more than half of the population never goes to school or spends very little time in a classroom.

"By interdisciplinary we mean that E.E. has to be a part of every subject that is taught. For example, suppose that you are studying pollution. In a biology class you might consider its effect on health, in chemistry and physics you might look at the techniques for combating it, while an economics class would examine the costs of pollution and of anti-pollution measures. A class on government could investigate who was causing the pollution and, finally, in sociology the students would discuss who lives in the most polluted areas and why."

The Belgrade workshop was the "kick-off" meeting of a three-year, \$ 4,000,000 project jointly sponsored by the United Nations Envi-



Jasminko Mulaomerovic, sarajevo, 1st Prize



Vojin Stonkovic, Banja Luka, 2nd Prize.

ronment Programme (UNEP) in Nairobi and Unesco in Paris.

For a start it was agreed to set up about 25 pilot projects in environmental education, five in each of five regions : Asia, Africa, the Arab States, Latin America and Europe-North America. These projects will deal with such fields as training teachers, using the mass media to educate people about the environment, and "re-educating" engineers, architects, lawyers and planners by giving them a new environmental dimension in their thinking and decision-making.

In the spring of 1977 there will be a conference at ministerial level, probably in Soviet Georgia. Its purpose is to translate into national policies what has been learned and decided throughout the world about environmental education in the previous two years. If one Belgrade workshop suggestion is adopted by governments and the UN organizations, 1977 will also be "Environmental Education

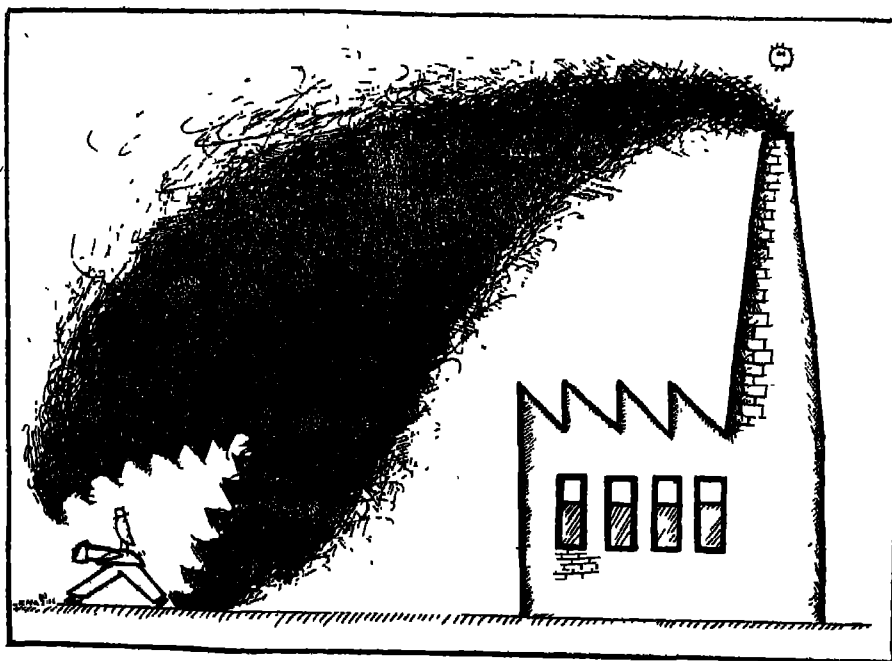
Year". These two events would do a lot to put E.E. on the map.

Unanimously approved, though strongly worded, the Belgrade Charter set the tone and laid down the road for the 19 or 20 months leading up to the meeting of education ministers in 1977.

— It said in part : "There is evidence of increasing deterioration of the physical environment in some forms on a worldwide scale. This condition, although primarily caused by a relatively small number of nations, affects all of humanity...

— It is absolutely vital that the world's citizens insist upon measures that will support the kind of economic growth which will not have harmful repercussions on people, that will not in any way diminish their environment...

— We need nothing short of a new world ethic to promote attitudes and behaviour in



Zoran Markovic, Nis.

individuals and societies which are consonant with humanity's place within the biosphere...

— (The) new kind of development will also require the maximum reduction in harmful effects on the environment, the utilization of waste materials for productive purposes, and the design of technologies that will enable such objectives to be achieved...

— The reform of educational processes and systems is central to the building of this new development ethic and world economic order. Government and policy-makers can order changes...but all of these are no more than short-term solutions unless the youth of the world receives a new kind of education...

The Belgrade Charter is a first step in this direction. To a sceptic who expressed doubts about "the practically unknown field of environmental education," a delegate replied: "15 years ago how many people had heard of women's liberation?...In another decade the whole world will be very much aware of the importance of environmental education."

Paul Evan Roes in *Unesco Features*

## Follow the Himalayan "garbage trail"

MAN'S quest to reach the highest summits is turning the mountain trails of the Himalayas into garbage dumps.

This was the gist of a report presented to a ten-day meeting on Unesco's Man and the Biosphere Programme (MAB), that began at Unesco headquarters this 17 November. In the report, Dr. Kamal K. Shrestha of Tribhuvan University's Institute of Science, said that the trekkers and mountaineers who come in their thousands to view the majestic peaks of the Himalayas have earned an unsavoury reputation for the cans, paper, bottles and

assorted rubbish they leave behind. In fact he termed one of the most popular routes—a 200-kilometre stretch to the Sherpa town of Namche Bazar—"a garbage trail". In the Solokhumbu area, the whole trail to the 5,350-metre high Everest Base Camp, is badly polluted by litter and conditions are getting worse every year, he said.

### *Risk of Irreversible Damage*

The damage is compounded by the fact that trekkers use the same sites time and time again to install their tents and kitchens. As Dr. Shrestha observed:

"If the present trend continues unabated, the degradation of the mountain environment may cause irreversible damage to the mountain ecosystem of Nepal, with negative consequences for the development of tourism in this country."

Tourism in fact has been climbing steadily since visitors began flocking to this landlocked mountain kingdom in the 1960s. Tourism is now Nepal's biggest source of foreign exchange. From barely 6,000 in 1962, the number of tourists rose to more than 70,000 in 1974 and 100,000 are expected by the end of 1975.

Interestingly enough, trekkers and mountaineers make up only 13 per cent of all tourists, though the country offers a choice of 240 peaks to scale. All the same, they numbered 14,649 in 1974, four times as many as in 1970.

Mountaineering teams are also on the increase. There have been 325 expeditions since 1949 when a British team explored Langtang and Ganesh Himan. This year alone there were 23.

The kind of equipment these expeditions carry varies considerably, Dr. Shrestha noted. The Austrians who climbed Mt. Manslu in 1973 used only 2.5 tons, whereas a Japanese team of women needed 21 tons to perform the

same feat (no explanation was given as to the kind of extra equipment).

The number of sherpas (guides) also varies considerably, with some teams employing as many as 800 and others only a handful. Since the average weight carried by a porter is about 35 kilos and 20 kilos at high altitude, the trail of discarded trash can be very long.

### *Depletion of Forests and Pastures*

Dr. Shrestha also called attention to the serious deforestation and diminishing supply of firewood along the trails. He estimated that about 800 tons of wood were used for camp fires and cooking in 1974. To this should be added several hundred tons used by mountaineering expeditions and the firewood burnt by pilgrims.

Pastures are also being destroyed by camping sites, and this destruction of the scant vegetation in Nepal's mountain regions has led to frequent landslides and rockfalls.

What can be done to stem further pollution? First, of course, trekkers must become more environment conscious. The British Mountaineering Expedition to Sagarmatha (Mt. Everest), now in Nepal, has taken a step in that direction by carrying only a minimum load and taking along all the necessary fuel.

Research will also be needed into the impact of man's activities on the ecosystem. Among suggested case studies under the Unesco/MAB Programme is one of the Langtang, a small valley which has been subjected to heavy tourism and mountaineering and is now a national park.

Nepal in fact is establishing as models for environmental protection four national parks and five wildlife reserves. Some of these may be included in the international network of biosphere reserves being set up under Unesco auspices.

Commenting on the results of this IOC/UNEP meeting, Dr. Keckes said they illustrate the desire of the Mediterranean countries—developed and developing—to do the job themselves.

But since everyone can see or smell pollution in the Mediterranean, why aren't scientists and governments acting instead of monitoring and studying?

"Because a visual guess at pollution is not enough," Dr. Keckes replies. "Two full years of standardized scientific investigation all around the basin are essential if we are to understand the level and the patterns, the causes and exact nature of the pollution—if we are to discover whether pollution is getting worse and if so, at what rate. Then we will give the Mediterranean governments the information they need to act, and it will be up to them."

To which Dr. Andrén adds: "Rome wasn't built in a day and neither has the Mediterranean become polluted overnight. So, it isn't realistic to expect to do away with pollution in a day or a year. It will take time. But we are making a promising start with these projects. They represent the first broad, collective effort covering the whole Mediterranean—and leading eventually to a permanent surveillance of its health."

### **Yugoslav towns, factories act to check river pollution**

A HEALTHIER life is in store for the Una river in Yugoslavia following an agreement between townships and factories on its banks to check pollution.

The accord, involving towns in Croatia and Bosnia-Herzegovina—the Una forms the common frontier—is part of a campaign to pro-

serve the environment in all six of the Yugoslav Federal Republic's constituent republics.

Mayors of towns on the Yugoslav coast recently met with their opposite numbers on the Italian side of the Adriatic to discuss tourism and how to better protect the sea against pollution.

Similar meetings to preserve famed lake sites, including Ohrid, Prespa, Dojran and Skadar, are planned with specialists from other neighbouring countries.

### **West Germany gives \$ 375,000 for preservation of Moenjodaro**

THE Federal Republic of Germany has donated 1,000,000 Deutsche Mark—about \$ 375,000—to Unesco's campaign to raise \$ 5,000,000 for the preservation of Moenjodaro in Pakistan.

The site, with its remnants of a civilization that flourished some 4,000 to 5,000 years ago, is threatened by underground water and the salt it carries. Preliminary conservation efforts are being directed at testing the effect of lowering the groundwater table.

The West German donation brings contributions to the Unesco campaign, launched in 1974, to \$ 570,000.

*Unesco Features*

### **Steps to curb soil erosion**

SINCE times immemorial soil erosion has been one of the major natural calamities affecting the fertility of agricultural land. In recent times, western countries have given utmost importance to this problem and they have effectively overcome the problem of soil erosion with the progressive use of modern technology.

"In India, particularly in Assam, conservation of soil has not received due attention and as a result we are not getting the expected results from our fields. Our farmers are also not aware of the loss of grains due to soil erosion as there has not been any concerted move to educate them about this problem. The rapid gushing of waters tearing down the hills into the swollen rivers and rivulets during the monsoons is causing havoc to the fields and heavy chunks of land from whole villages are eroded every year. Gully erosion is eating away the paddy fields right down to the very edge of the villages.

However, as late as 1954, the Government of Assam created a separate division in the Forest Department to check the erosion in the hill areas, thereby reducing the incidence of low yield of crops. Success of this division encouraged the government to create a separate Department of Soil Conservation in 1959. This department is now engaged in tackling the centuries-old problem of soil erosion caused by the peculiarity of the soil, destruction of forests, faulty irrigation and lack of provision for disposal of excess water.

#### *Tackling Erosion*

The functions of the Soil Conservation Department in the hills is to replace shifting cultivation by other scientific methods of using the land. In the plains, its primary objective is to control river bank erosion and gully erosion. In the north bank of the Brahmaputra, considerable areas of productive paddy fields are eroded away by formation of ravines, called gullies. The total area affected by gully erosion on the north bank of the Brahmaputra is about 12,500 hectares. About 1,000 hectares are damaged by gully erosion annually.

To check soil erosion in the plains the department has taken up a number of schemes which are showing encouraging results.



The schemes include : (i) Gully control works by engineering and vegetative methods which are simple and based on local resources. (ii) Afforestation of the banks of rivers changing courses. The department has been able to stop the changing of river courses by afforestation, etc.

---

### STUDY OF ATOM

---

#### Nuclear accelerator enables atom study

AUSTRALIAN scientists are continuing a detailed study of atoms and their nuclei using a *tandem nuclear accelerator* which is the most powerful of its kind in the world.

The Department of Nuclear Physics in the Research School of Physical Sciences at the Australian National University in Canberra has been host of the work since its 14UD tandem nuclear accelerator was completed in 1973.

According to the Head of the Department, Professor John O. Newton, the work is motivated "by man trying to understand the world in which he lives. "In other words, the aim is pure science", he says.

Professor Newton says this justifies the research. He says that increased understanding resulting from pure research enables developments in technology, where applied scientists and engineers turn discovery to practical use.

He cites the example of the laser—a product of pure research—now "a great utility of industry and medicine." The laser's latest application is in uranium enrichment, which Professor Newton says might eventually cause a revolution in the economics of nuclear power production.

To study the structure of an atom or nucleus of an atom, ingenious methods are required because the subject is so small. An atom cannot be seen through a microscope. If

100,000,000 atoms were lined up, they would be only about 1 cm long. The atom's nucleus is between 10 and 1,000 times smaller again.

Professor Newton says physical reasons prevent electron-microscopes or X-rays being used to study atoms and their nuclei.

"We, therefore, have to use a different method of approach to study their structure", he says. "Our approach can be illustrated by the following analogy : if we want to find out how a car engine works, we usually take it apart and look at it.

In the 14UD tandem accelerator, the electric field is generated by producing a very high positive voltage—up to 14,000,000 volts at the accelerator's terminal.

To obtain this voltage, the machine must be contained inside a pressure vessel filled with an insulating gas, sulphur hexachloride. There is about 30 tonnes of sulphur hexachloride inside the 14UD's tank.

Negative ions in the tandem accelerator—atoms with one extra electron attached—obtained from a plasma source are injected into the low energy end of the accelerating tube. They pass through a thin carbon foil stripper, which as the name implies removes a large number of electrons, causing the ion to emerge positively charged.

Electromagnetic lenses placed along the path of their journey refocus the ions, so they continue towards the target. An analysing magnet bends the beam through 90 degrees. This serves several functions, including converting the vertical beam to a more convenient horizontal one.

It also allows selection of ions with the exact desired charge, preventing unwanted ions continuing along the journey to the target.

The university is using ion beams to study crystal structure, as a tool in solid state physics and to study spectral lines critically important in plasma physics and astronomy.

## ENERGY AND EARTHQUAKES

**Geothermal power may trigger**

EXPLOITATION of geothermal energy, as an alternative to fossil fuels, could entail a new ecological disturbance--man-made earthquakes.

This warning was delivered by an American scientist, Dr. Carl Kisslinger, University of Colorado, to the first International Symposium on Induced Seismicity.

Dr. Kisslinger said :

"The development of geothermal deposits for energy production requires both the withdrawal of fluids (subterranean water) from the geothermal reservoir and the reinjection of these fluids after the heat has been extracted. Thus two procedures known to induce seismicity under certain circumstances are involved and the inadvertent triggering of earthquakes must be considered as a possible consequence of geothermal power development."

The symposium was attended by some 100 participants from 22 countries, most of them representing professions that ordinarily do not get together. Among them were seismologists, mining geologists and engineers, hydrologists, researchers in experimental rock mechanics (who simulate earthquake effects by cracking rocks

in the laboratory), dam designers and insurance experts.

They were treated to a view of what may be the first photograph ever taken of the actual epicentre of an earthquake. It looked like a light-coloured bend in the rock, about four centimetres wide and powdery in texture, the result of heat and grinding along the fracture plane.

Such a deep extensive mine covering many square kilometres constitutes, as it is noted, "a virtually complete seismic system of intense activity". Epicentres of induced earthquakes can be located and even examined.

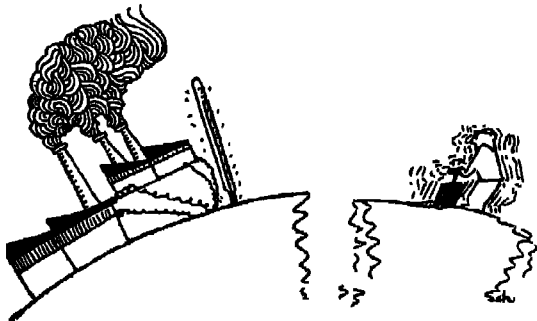
"Miners have long known that the rock 'talks' and 'bumps' in response to the stress changes induced by mining". Seismographs in the vicinity of the Witwatersrand mines record peaks in activity corresponding to daily blasting—and a steep drop on Sunday when the mine is closed.

One of the best-documented sources of manmade earthquakes are the reservoirs created behind large dams 100 metres or more in height. There are now 275 such reservoirs in the world with another 135 proposed or under construction.

*Chinese Experience*

The symposium heard Chinese scientists describe the earthquakes that have occurred at the Hsinfengkiang Reservoir 160 kilometres northeast of Kuang-chou (Canton). Work on the Hsinfenkiang dam 105 metres high was started in 1958 and impounding of its reservoir began a year later.

Frequent earthquakes occurred soon after. Seismographs were installed on the site and the dam was strengthened to stand up to a magnitude six earthquake, a wise move for that was precisely what happened in 1962, leaving the dam with a crack, subsequently repaired, 82 metres long.



The Chinese agree with other investigators that it is not the weight of the water in the reservoir that is directly responsible. At Hsinfengkiang, water apparently infiltrated cracks in rocks, penetrating deeper and deeper, and weakening their ability to withstand sheer, the rupture or thinning-out of rock strata by compression.

Daniel Behrman in *Unesco Features*

---

## SCIENCE AND PEOPLE

---

### Weather in service of economy

In a country like India where agricultural output depends to a large extent on timely rains, the knowledge of weather conditions is very useful in planning economic development. Advance weather forecasts not only forewarn us of the impending natural calamities like cyclones and floods but also furnish information which is of great help to farmers.

During the last decade new meteorological services have been started to serve various weather sensitive sectors of the economy. In order to provide meteorological forecasts and climatological data to authorities in each State for planning agriculture, irrigation and industry, meteorological centres have been established at capitals of 10 States in addition to the existing 5 Regional Centres. These centres issue daily weather reports and forecasts as well as warnings of heavy rain, cyclones, cold waves etc. to the public of each State through All India Radio and newspapers.

#### *Crop Yield Forecasts*

Formulae have been developed for issuing crop yield forecasts of wheat and rice in various

meteorological divisions in the country based on meteorological factors. These experimental forecasts will be extended to the State and sub-divisional level during the coming few years.

#### *Meteorological Statistics for Agricultural Planning*

Probabilities of occurrence of rain during different weeks of the monsoon season have been worked out on the computer for 160 stations in the dry farming zone. Statistics of most appropriate sowing periods have been worked out for different districts of Maharashtra. The work will be extended to other States in the country so as to provide scientific information to the farmer regarding period of occurrence of rains suitable for sowing and intervals between two rainy periods in order to plant types of crops and suitable periods of agricultural operations.

#### *Monsoons, Floods and Droughts*

In order to study the characteristics of the monsoons and its vagaries which are responsible for floods and droughts; a Monsoon Experiment was conducted in the monsoon season of 1973 in collaboration with scientists of USSR. An international Monsoon Experiment (MONEX) is being planned under WMO auspices during 1978-79. A drought research unit has been set up at Poona and research in climatic changes are being planned.

#### *Irrigation and Flood Control*

Seven flood meteorological centres have been established in the catchment areas of flood prone rivers in the country. Automatic radio-reporting raingauges have been designed and manufactured in the departmental workshops to get information from remote mountainous areas for prediction of flash floods. Six such radio-reporting raingauges have been installed in the Teesta and Narmada catchments. A total of 50 radio-reporting raingauges have

been planned during the 5th plan period. Powerful S-Band radars at Calcutta, Paradeep and Visakhapatnam will be used to estimate the amount of rain in flood producing stations. Four more such radars will be installed for flood forecast purposes.

#### *Energy and Power*

Meteorological forecasts of rain and snow are issued to various hydroelectric reservoirs in the country. Experiments to augment rainfall by artificial means were conducted over the Rihand reservoir during the monsoon seasons of 1973 and 1974. A ten year programme for use of latest techniques for rain-making experiments in the country has been drawn up. Data of wind speed, solar radiation and duration of sunshine useful for utilisation of wind-power and solar energy have been collected from all over the country and are being analysed.

#### *Natural Disaster Prevention*

In order to provide advance warnings to coastal public about impending cyclonic storms, four powerful cyclone warning radars have been installed along the east coast and one along the west coast. Three more radars are planned during the 5th plan period. Cyclone Distress Mitigation Committees have been constituted by three State Governments along the east coast and have prepared plan for prevention of loss of life and property in cyclones.

#### *Air Pollution*

To determine the extent of dispersal of pollutants in the air micro-meteorological towers are being set up at the new steel mill sites in the country. Meteorological instruments will be installed on TV towers at Bombay, Delhi and other cities. Urban climatological stations have been started at a number of centres in Delhi and other cities.

#### *Oil Exploration*

For the ongoing offshore drilling operations in Bombay high and projected operation at other areas in the Arabian Sea and Bay of Bengal, a project is being drawn up to provide data on the wave heights over these areas and techniques of forecasting these waves during periods of operations. These data are crucial for the safe operation of drilling rigs particularly during the monsoon season.

---

### HONOURS & RECOGNITION

---

#### **Award for science and mathematics teachers**

GUINNESS Awards, instituted by the Commonwealth Association of Science and Mathematics Educators (CASME), is to encourage the school and college teachers of the U.K. and overseas for proficiency in the teaching of science and mathematics. The CASME awards scheme is intended to reward original teaching carried out to produce a reasonable assessment. In recent years, the social aspects of science and mathematics teaching have been emphasized and their relevance to technology and agriculture is duly recognized.

The three hundred pound award will be provided by CASME. If the judges feel that no candidate has submitted an entry, worth the award, the first prize will not be awarded and the prize money may be divided according to the Judge's recommendations.

Entries are invited from the teachers working in primary, secondary or tertiary educational institutions. The entries may be submitted by either individuals or syndicates (science staff of a school or college or from more than one school or college). Only one entry can be accepted from one entrant.

syndicate. The entry must be written or typed on one side of quarto sheets of paper and should not exceed 10,000 words. Photographs and other illustrative materials should be included wherever relevant. References should be made to the source of information or original experiments wherever necessary. Information about the publication or submission of any substantial part of the work should be mentioned on the top sheet of the entry. Credits will be given for original thoughts and ingenious applications. The work should be based on personal. The entries must provide information on the background, objectives, procedure, results and conclusions, and future

prospects of the work.

The write-up on the selected topics should be based on the personal or team experience and must include account of teaching and/or education work. Entries on suggested schemes, new programmes or revised syllabi which have not been tried out will not be entertained. The entry can be returned for re-submission at a later date, if it needs some modification.

Full details and registration form can be procured from the British Council Office (21 Jor Bagh, New Delhi-110003) or directly from the CASME Awards, C/o Education Project Department, The British Council, 10-Spring Gardens, London SW<sub>4</sub>A<sub>2</sub>BN, U.K.

sent. In certain contexts, it is convenient to regard a photon as an elementary particle.

**Plasma (Physics) :** Plasma is a completely ionized state of matter. It is, therefore, also described as the fourth state of matter. The numbers of positive ions and electrons in a plasma are approximately equal. Therefore, the plasma is virtually electrically neutral and highly conductive.

## Scientific Terms

### *Used in This Issue*

**Corona :** A white irregular halo surrounding the sun, visible during a total eclipse. In the article "Corona Chemistry," the term has been referred to corona discharge—a discharge of slight luminosity, at atmospheric pressure, which appears round the surface of a conductor due to ionization of the air or other gas surrounding it, caused by the voltage gradient exceeding a critical value for the gas in question.

**Geothermal :** Pertaining to the heat from inside the earth.

**Photon :** A quantum of electromagnetic radiation having zero rest mass is called *photon*. All photons are not alike. They vary in energy contents in direct proportion to the frequency of radiation they repre-

**Raman Effect :** Named after Sir C.V. Raman (India : 1888-1972). When monochromatic light passes through a transparent medium, some of the light is scattered. If the spectrum of this scattered light is examined it is found to contain light with wavelengths other than the original one. The scattered light are due to the loss or gain of energy gained by the photons of light passing through the transparent medium.

The Raman Effect is therefore helpful in the study of molecular energy level.

**Rheostat :** A variable electrical resistor.

**Seismograph :** An instrument for recording and measuring earthquake shocks.



# NCERT

## Supplementary Readers in Science for Schools

1. *Weapons : Old and New*  
by Mir Najabat Ali
  2. *The Universe*  
by P.L. Bhatnagar
  3. *The Life and Work of Meghnad Shah*  
by Kamalesh Ray (Hindi edition also available)
  4. *The Discovery of the Oceans*  
by N. Balakrishnan Nair
  5. *The Life of Insects*  
by T.N. Ananthakrishnan
  6. *Non-Flowering Plants of the Himalaya*  
by M.A. Rau
  7. *ABC of the Atom*  
by A.K. Samban
  8. *Faster and Farther—The Story of Transport*  
by Mir. Najabat Ali (Hindi edition also available)
  9. *Medicinal Plants*  
by S.C. Datta
  10. *Rocks Unfold the Past*  
by Vishnu Mittre
  11. *Our Agriculture*  
by S.K. Mukherji
  12. *Plant Viruses*  
by Anupam Varma
  13. *Birds and Bird Watching*
  14. *Marine Plants*
- SOME OTHER TITLES
15. *Probability*
  16. *About Flying*  
by Neena Kaushal
  17. *Space Flights*  
by Mohan Sundara Rajan

# School Science

Vol. XIV No. 2  
June 1976

A QUARTERLY JOURNAL OF SCIENCE EDUCATION

---

## CONTENTS

### 1 EDITORIAL

<i>Utpal Mallik</i>	3	Jacques Leucien Monod : A Profile
<i>Nasim Siddiqui</i>	5	Programmed Instruction : Physics
<i>Arun K. Mishra</i>	9	Cell Biology in High Schools
<i>S. P. Singh</i>	15	T. H. Huxley on Teaching of Science in Schools
<i>A. P. Verma</i>	18	Transfer Technology Related to School Science Equipment
<i>A. Venkatacharlu</i>	29	Magic Squares

### 33 AROUND THE RESEARCH LABORATORIES

<i>O. L. Orekhov, B. D. Atreya</i>	37	The System of Education in the USSR
------------------------------------	----	-------------------------------------

### 47 SCIENCE NEWS

### 59 BOOK REVIEW

### 60 SCIENTIFIC TERMS

COVER : Galileo Galilei (1564-1642), Italian astronomer and physicist peering into the sky. The success of Viking I can be traced back to such pioneers,



## TO OUR CONTRIBUTORS

SCHOOL SCIENCE is a quarterly journal intended to serve teachers and students in schools with the recent developments in science and science methodology. It aims to serve as a forum of exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc. should be neatly typed, double spaced on uniformly sized paper, and sent to the Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110016. Each article may not normally exceed 10 typed pages.

The articles sent for publication should be exclusive for this journal. Digests of previously published articles modified to suit the scope and purpose of SCHOOL SCIENCE will be accepted. In these cases the name of the journal in which the original article appeared must be stated.

Headings should not be underlined.

Selected references to literature arranged alphabetically according to the author's name, may be given at the end of the article, wherever possible. Each reference should contain the name of the author (with initials), the title of the publication, the name of the publisher, the place of publication, the volume and page numbers.

In the text, the reference should be indicated by the author's name followed by the year of publication enclosed in brackets, e.g. (Passow, 1962). When the author's name occurs in the text, the year of publication alone need be given in brackets, e.g. Passow (1962).

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of postcard size, and should be sent properly packed so as to avoid damage in transit. ☐

---

## EDITORIAL

---

THE SCIENCE FOR ALL programme in the new pattern of school curriculum cannot serve its purpose if the methodology of science teaching cannot be improved beyond the existing chalk and talk method. We have adopted the national framework after a nationwide discussion at all conceivable levels. The curriculum framework for the ten-year school suggests the "upgrading of science teaching in order to teach scientific method of enquiry and prepare the students for a competent participation in the changing society and culture, increasingly depending on a rational outlook leading to better utilization of science and technology." The framework also stresses the need for acquiring useful knowledge and skill, proper work habits, attitude and character as the objectives of science instruction. It also envisages that the scientific knowledge is built not on abstract concepts alone but also on the solid foundations of experience. The framework is equally clear about the methodology of teaching. Direct observation of natural phenomena with simple aids by the students and investigatory or experimental approach has been recommended.

It can hardly be disputed that the test of the pudding lies in eating. But unfortunately confusion and misgiving seem to persist in some quarters. Some of the new curricula prepared for different regions do not encourage or include any field or lab. activity for the students. The obvious reason for this is the limitation of financial resources and lack of laboratory facilities in schools. But would it not be more reasonable to suggest several alternative student activities based on the day to day experience of the students and available resources and to face the challenge rather than abdicating the academic responsibility altogether?

A laboratory is just as essential for teaching science as the swimming pool is for training how to swim. But a laboratory is not conceived merely as a four-walled room displaying a number of costly equipment. It has assumed a broader connotation; any situation that enables one to perform an experiment, test a scientific assumption or make a useful scientific observation may be looked upon as a laboratory. A laboratory for the school students need not

necessarily be sophisticated; just the opposite may even be better to stimulate problem-solving abilities.

So we should try to cut down the cost of equipment, try to conceive new learning activity and rely more on innovation keeping the aim within our reach instead of depriving our students of the precious feel, fun and taste of learning science. Needless to say, the schools and the teachers should be given all sorts of help and encouragement to overcome the odds. Institutional and individual efforts have already been made in this direction and the results seem encouraging.

After all, it is well known that a large number of basic scientific principles can be derived from observation and experiments with very simple things. The items in the inexpensive kit designed by the NCERT can still be simplified and substituted by locally available materials. A large number of biological principles can be derived from the field studies in the school compound or a nearby pond. The classroom demonstration may cover the rest. Surely, the nation should not grudge the little expense that may still have to be incurred for educating our future citizens. □

## Jacques Leucien Monod : A Profile

UTPAL MALLIK  
*Department of Education  
in Science and Mathematics  
NCERT, New Delhi*

JACQUES LEUCIEN MONOD died in Cannes, Southern France, on 31 May 1976. He was 66.

A scientist of the highest calibre and one of the foremost philosophers among the modern biologists, Monod was a rare phenomenon.

He was born in Paris in 1910 of a French father and an American mother.

Monod's scientific career was eventful. He obtained his first degree in 1931 and the doctoral degree a decade later, both from Paris. Monod profited from the free and lively scientific atmosphere at Morgan's laboratory during his brief stay of less than a year (1936) at Caltech. He joined the Pasteur Institute in 1946 as Chef de Laboratoire, and became Chef de Service in 1953. The headship of the Department of Cellular Biochemistry followed (1954). In 1971, he was appointed as the Director-General of the Pasteur Institute. Simultaneously, however, he held a chair at the University of Paris (1959-67) and a chair in Molecular Biology at the College de France (1967-72).



JACQUES LEUCIEN MONOD  
(1910-1976)

Since 1962, Monod was a Non-Resident Fellow of the Salk Institute; he was a foreign member of the Royal Society, U.K. and the National Academy of Sciences, United States.

In his formative years, Monod was greatly influenced by his immediate elders—Andre Lwoff, Boris Ephrussi and Louis Rapkine. His early research career was difficult. But relentless logic, tenacity and versatility ultimately made Monod one of the outstanding leaders of modern biology.

In 1961, Monod and Francois Jacob collaborated in writing a paper in genetic regulatory mechanism, culminating in the synthesis of a verified hypothesis. This was a general model for induction and repression of specific protein synthesis. It unveiled the intriguing

---

Photo : Courtesy French Embassy, New Delhi

strategy of genes in lower forms of life. This, however, is no occasion to tell the story in details nor to emphasize the implications of the model. Eventually, Monod shared the Nobel Prize (1965) in Physiology and Medicine with Francois Jacob and André Lwoff for elucidating the replication mechanism of the genetic material and the manner in which the cells synthesise protein.

Monod compiled his Robbins Lectures at Ponom College, California (1969) into the controversial book *Chance and Necessity*. Subsequently, he had rewritten the volume in French as *Le Hasard et la Nécessité*. It evinced almost united opposition in France. Still, there is no denial that it is an absorbing book, "lucid and intelligible, alike to the non-scientist and the novice in philosophy". Written with the characteristic clarity of a French writer of prose, the book presented Monod's view of the universe—arid and austere. It makes one think over and feel for the "deep rift between science and the rest of our culture".

The essence of Darwinism young Jacques inherited from his father. He was thoroughly convinced of the Darwinian principles. This

would lead him, at a much later phase of his life when he expressed his general ideas about biology, man and human society, into severe controversy with a great majority of the French intellectual establishment. The latter, however, has more often banked on Marx and Teilhard de Chardin than on Darwin and Mendel, at least in such issues like man and his society.

Molecular biology was Monod's own forte. If any single human being could be miraculously magnified to symbolize a branch of human knowledge, Monod would have symbolized molecular biology.

Monod's was a taste truly refined and a range of gift rare. His wide intellectual curiosity brought him close to classical and modern literature. Molecules and music attracted him alike; a keen interest in the latter he had derived from his father who was an artist. Monod combined in himself, in natural harmony, a philosopher, a scientist and an equally accomplished musician.

Jacques Monod earned his place in the history of modern science and his achievements will be a beacon for the generations of biologists to come. □

## Programmed Instruction : Physics

NASIM SIDDIQUI  
*Field Adviser (Physics)*  
*Directorate of Education*  
*Karol Bagh, New Delhi*

THE GOALS and expectations of the science education change with time and with them the curriculum. As the curriculum evolves so must the role of the science teacher. The NCERT has developed new science courses for primary, middle and secondary levels. Usually the schools have 8 periods of 30-40 minutes' duration. Regular teachers also work as substitute (arrangement) teachers during their vacant periods besides their teaching 6-7 (out of 8) periods daily.

Many educators believe that the traditional teaching methods, which are geared to imparting factual knowledge to students should be revised. Tradition has given the schools classrooms and class teaching but children can learn in many other situations. There is an urgent need to devise learning situations in which children are fully involved so that they clearly and fully understand the process of learning.

If one were to list expressions that best describe education for the 1970s, "individualized instruction" certainly has to be included. Individualized instruction is not new. It has been used for centuries for a too advanced child. It is, however, a new experience when we use this technique to teach the entire class, where students are working independently under the guidance of a teacher at their individual rates to accomplish what they know is expected of them in the way of the objectives of the course.

The science teacher today is faced with the problem of how to teach what is given into his hands.

The programmed instruction is one of the most efficient ways of providing individualized instruction. The textbooks developed by the NCERT and other teaching material available in the market are written in a traditional way. They are not designed to teach but to convey information to the students. In programmed instruction a programmer determines for a student, what he should and what he should not assimilate. The student is guided along a path and given those experiences that will cause him to learn those things. While no such guidance is given in a textbook.

If the teachers could have well-sequenced programmed materials, it would be a great help to them since they are heavily loaded. Also, if the programmed materials provided activities of 20-25 minutes' duration, the students would have more opportunity to do the experiments themselves even in smaller periods.

The adjunct programming can be a link between the programmed instruction and a

good textbook. It combines some of the progressive features of programmed instruction with the comprehensiveness of textbooks. The goal of adjunct programming is to enable the students to learn as effectively as possible from a good textbook. An adjunct programme may be one of the two types: (1) the text itself is kept intact and the programme is supplied as a separate unit, or (2) sections of the textbook are extracted verbatim and used in the programme as the basic information. In our set-up the most popular procedure will be to leave the textbook intact.

Cowan (1964) developed an adjunct programme for PSSC physics (1960, first edition) at the University of Texas in 1962. This material was used later by his students as a study guide in his 1964 research study "Development of new auto-instructional materials and an analysis of their effectiveness in teaching modern physics in small high schools".

Cowan did not use qualified physics teachers in his experimental classes. Teachers in the experimental classes had no background in physics and they were acting only as adult supervisors. The written assignments too were sent to Cowan at the University of Texas at Austin (400-600 km. away from the schools) for correction and grading. Cowan found that there was no significant difference in the mean level of achievement in PSSC physics between students of comparable mental ability, reading ability, and science background not using such materials but taught by a physics teacher in a conventional way.

Cowan's auto-instructional materials were revised for PSSC (1965, second edition) text by Siddiqi at Florida State University in 1972, which he later used in his 1973 research study

"An analysis of the effectiveness of the use of auto-instructional materials in the teaching of PSSC physics by qualified physics teachers" with a different kind of teaching set-up.

The problem in this study was to determine if there is a significant difference in the mean level of achievement in PSSC physics between the students using the auto-instructional materials, supervised by a physics teacher, and the students studying PSSC physics without such materials in a conventional teacher-taught classroom situation.

The sample to which this research applies was drawn from five public (government) high schools and one private high school (IX-XII) in Florida. The experimental group consisted of four classes (66 students) and the central group also consisted of four classes (105 students). These schools were selected on the basis of their willingness to participate in the study.

Students of both the groups studied from the same PSSC physics text, worked the same numerical problems from the text, viewed the same PSSC films, and performed the same experiments from PSSC lab. manual. Students of the experimental group used the auto-instructional materials, written for Part I and II of the second (1965) edition of PSSC text, under the guidance of their physics teacher. Students of the central group did not use such materials, they were taught PSSC physics by their teacher in a conventional way.

The PSSC standardized texts 1-5 were administered to both the groups at appropriate time during the study (September 1972-February 1973) to permit the comparison of the achievement of the two groups. The mental ability, reading ability, science background, verbal

reasoning ability, mathematical aptitude and mathematical achievement were used as covariates. These scores were collected from school records for all the subjects.

Analyses of covariance were performed with physics achievement as the dependent variable and stannies of mental ability, reading ability, science background, verbal reasoning ability and mathematical aptitude, and grade-point average for mathematical achievement as covariates.

When physics achievement scores for both the groups were adjusted for these covariates, the experimental group demonstrated a statistically higher level of achievement in PSSC physics.

Subjective techniques were also employed to obtain data that would be useful in the evaluation of the auto-instructional materials. Direct observations of students engaged in using the materials were made. Students and teacher responses to certain written and verbal questions regarding effectiveness of the materials were collected by means of student and teacher (separate) response sheets, and audio-taped student and teacher interviews respectively.

During visits to the experimental schools, the investigator found that most of the students were actively engaged in their work. They were following the directions given in the auto-instructional materials for using the text, doing labs and solving problems. Whenever needed, they were consulting their teacher individually or in small groups.

Most of the students and teachers liked the materials and their approach to the instruction. They felt that individualization, independence,

self-pacing, self-evaluation, and better use of the teacher's time were some of the merits of this type of instruction. More than half of the students and teachers liked the individualized instruction. They reported that, using this approach of instruction, the teacher had more time to interact with individual students. They pointed out that the auto-instructional materials made PSSC physics easier for the student. More than half of the students liked the idea of moving at their own pace.

If achievement is accepted as a criterion for measuring the effectiveness of a programme on the basis of the results reported in this study, the auto-instructional materials used to teach physics in schools were more effective than the conventional method. The sample obtained might be considered to be somewhat representative of the school population within the State of Florida and possibly elsewhere in the United States. Similar results for students could also be expected in our schools in India.

The technique of individualized instruction should be tried out to teach Unesco Project physics in Classes VI-VIII, and IX-X physics under the 10+2+3 scheme. The adjunct programmes should be developed for these texts. Some physics texts should be divided into smaller units, if possible, and some of these units should be programmed and used in some schools on a trial basis. There is a lot of scope for research in developing and evaluating such programmes in the field of physics education. If positive results are obtained similar work could also be done for XI-XII physics under the 10+2+3 scheme as well as for other science subjects at all the four levels—primary (I–V), middle (VI–VIII), secondary (IX–X), and post-secondary (XI–XII).



SCHOOL SCIENCE JUNE 1976

## REFERENCES

COWAN, PAUL JACKSON, "Development of new auto-instructional materials and an analysis of their effectiveness in teaching modern physics in the small high schools", Doctoral dissertation, The University of Texas, May 1964

ESPIGH, JAMES E. and WILLIAN, B., *Developing Programmed Instructional Materials*, Pale Alto, California ; Eearon Publishers, 1967

SDDIQL, MOHAMMED NASIM, "An analysis of the effectiveness of the use of auto-instructional materials in the teaching of PSSC physics by qualified physics teachers".

(a) Doctoral dissertation, The Florida State University, August 1973

(b) *Dissertation Abstracts International*, Volume 34, November 1974

(c) Abstracts of Presented Papers, NARST, 1974 (pp. 204-205)

(d) Contributed Papers, IV-A (18 April 1974) NARST, 47th Annual Meeting, 15-18 April 1974, Chicago



# Cell Biology in High Schools

## Place of Cell Biology in Contemporary Life Science Syllabi

ARUN K. MISHRA

*Department of Education in Science and Mathematics  
NCERT, New Delhi*

It is not necessary to go back more than fifteen years from today in order to trace the inclusion and gradual expansion of the topics of cell biology in the life science syllabi of our schools and colleges. In the early sixties only a few of the topics such as cell structure and cell divisions in the domain of the cell's life processes were taught in our universities. A few universities started including some of the topics in this area in a rather fragmentary way in their advanced courses, after certain breakthroughs in the field of molecular genetics and cell ultra-structure became too apparent and pressing to be ignored. The proportions of these topics gradually increased as the teachers, interested in cell biology, became available. But even today there are only a few universities in the country, which present the important topics in cell biology in a systematic and coherent way.

In the context of schools, introducing an up-

to-date syllabus for life science is more difficult than it is for the universities. The teaching learning situation varies so much from one school to another all over India that it seems almost impossible to introduce a uniform syllabus for all. However, a chain of schools affiliated to the Central Board of Secondary Education, New Delhi, represents the largest single national system. Besides the numerical superiority, it contains in its fold the best of the country's public schools, Central Schools and the schools of a few states. In collaboration with the National Council of Educational Research and Training, New Delhi, their curriculum and textual materials are kept up to date. The model of NCERT and the CBSE will provide the background for the proposed analysis and coverage in this article.

The first cognizable attempt in improving the biology teaching was made when Prof. P. Maheshwari of Delhi University was invited by the NCERT to coordinate the task of preparing standard biology texts. The first part of the book *Biology—A Textbook for Secondary Schools*, edited by Maheshwari and Lal, was published in the year 1964. In the foreword, Prof. Maheshwari mentioned "cell physiology" as an organized sub-discipline of biology along with evolution, ecology and heredity. In this series, the subject-matter covered the essentials of cell structure, divisions, variations in cell size and shape at one place by way of structural organization; cell as physiological unit, composition of protoplasm, energy and enzymes, photosynthesis and chemosynthesis, respiration and utilization of energy by way of life processes; and the nature of genes and mutation came next. Though boldly introduced, cell physiology as a unit, however, remained unorganized.

By the end of 1970, the NCERT published a new syllabus on the basis of the reports of the Unesco Planning Mission and the Indian Education Commission. In this syllabus in the second year of the 3-year secondary school, a whole unit of 90 periods, named "The Molecule and the Cell" was included comprising such topics as the structure of the cell, the chemical basis of life, metabolism and exchange of energy in cells and reproduction of the cell.

Only a few topics which could have been included in this unit were put either in the first year such as photosynthesis and respiration, or in the third year such as DNA, RNA, gene actions and interactions. This syllabus, however, gave us the best organization available for cell biology for school education.

But for one reason or another the texts prepared by the NCERT after this date neither followed the plan proposed above, nor found acceptance by the CBSE schools.

#### PRESENT POSITION

During the 1975 academic year, the CBSE introduced the new 10+2 pattern in its schools and life science was made a component of the "science for all" programme for Classes IX and X. The new life science syllabus for Classes IX and X of the CBSE and the corresponding texts prepared by the NCERT organized things differently from what was previously proposed. Aspects of cell structure and function were dealt with in the context of levels of organization; photosynthesis and respiration, though based on the cell energetics, found place along with a general account of other life processes and aspects of the nature of gene in the unit on the continuity of life. The informational system of the cell (DNA-RNA-Protein) was

left to be discussed at more advanced stages and thus the coherence of thought in cell biology was sacrificed in giving biology a broader base in order to bring the "Life Sciences" closer to life and community.

At the terminal stage of the secondary education biology is to be taught as an elective subject claiming about 20 per cent of the total instructional time in contrast to nearly 5 per cent at the lower secondary stage.

It is also meant for maturer minds of the youths of 16+ to 18+.

In the proposed syllabus to be implemented from the 1977 academic year, cell biology has been restored to a significant position in terms of recent advances and the contemporary global trends. The same can also be said for the other proposed areas of biology such as systematics, anatomy and physiology at the organismic levels, man and environment, developmental biology, genetics, and biology and human welfare.

Our main concern here is cell biology which has been assigned one-fifth of the time available for biology during the two years. It also comprises the collection of the important areas of cell biological research at one place with exceptions of cell water relations and photosynthesis which find place along with other life processes of plants. The topics covered scan cell theory, the methodology employed in cell studies, the nature of molecular building blocks, biomembranes, cellular respiration, cell organelles (structure and function), enzymes-vitamins and hormones with accent on their structure, mode of action and the regulation of cellular activities. The detailed structure of nucleus, chromosomes, DNA along with DNA replication, transcription and translation. Genetic coding and protein synthesis have also been included here. It is also stated in the objectives

of the course that the teaching should emphasize not only the latest position in terms of principles and generalizations but also their development in a semi-technical presentational

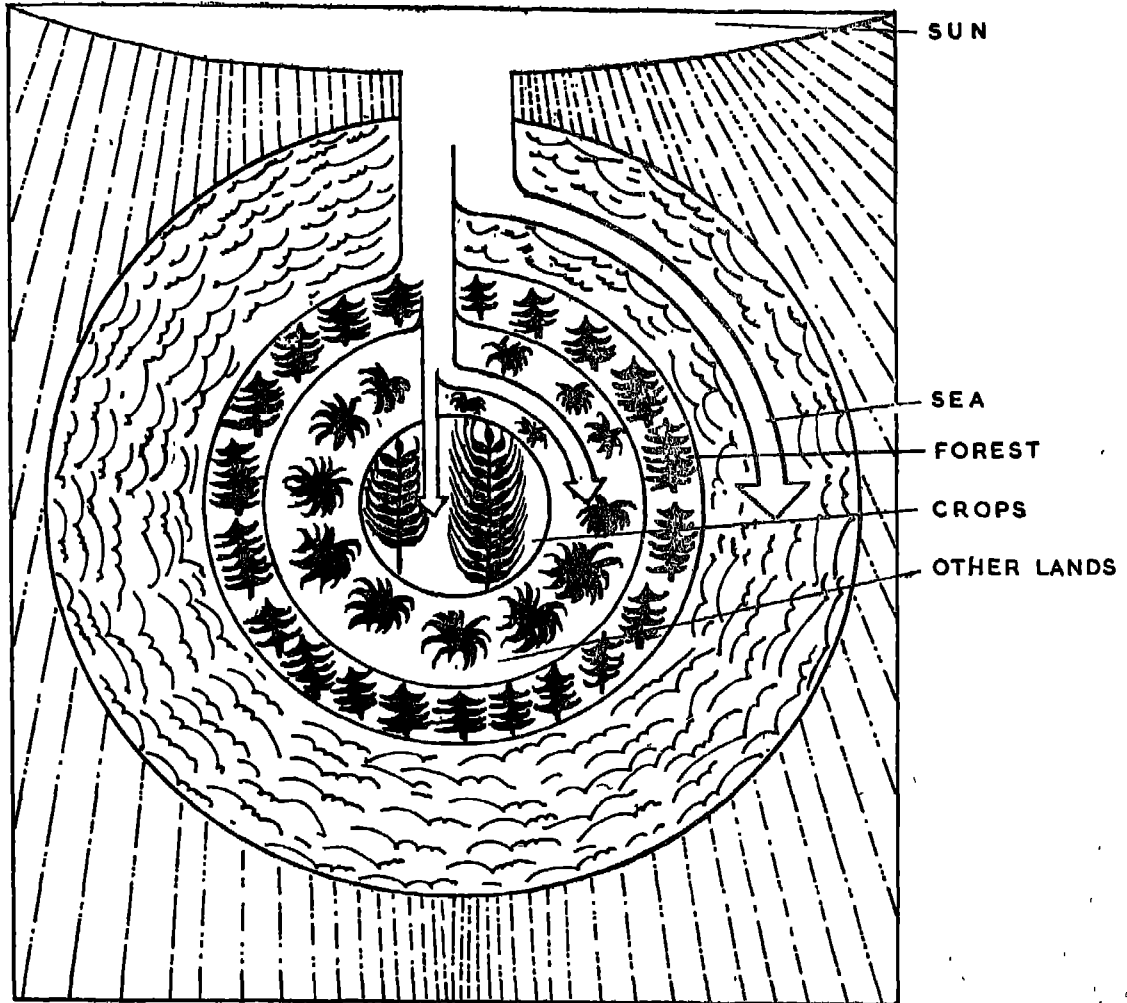


FIG. 1. Sun is the major source of energy on earth. The trapping of solar energy is a cellular process. Only a small fraction of solar energy is available to us through our crops. How could we harness more of this unlimited energy reserve? We must know more about photosynthesis.

style. This being the latest national model of cell-biological subject-matter it remains to be seen how in coming years it gets best implemented. Besides several other factors, a great deal would depend upon the text and supporting materials developed for this purpose that

become available to the teacher before he enters the classroom in the year 1978. The present syllabus will undoubtedly leave an impact and a challenge to be met in later years.

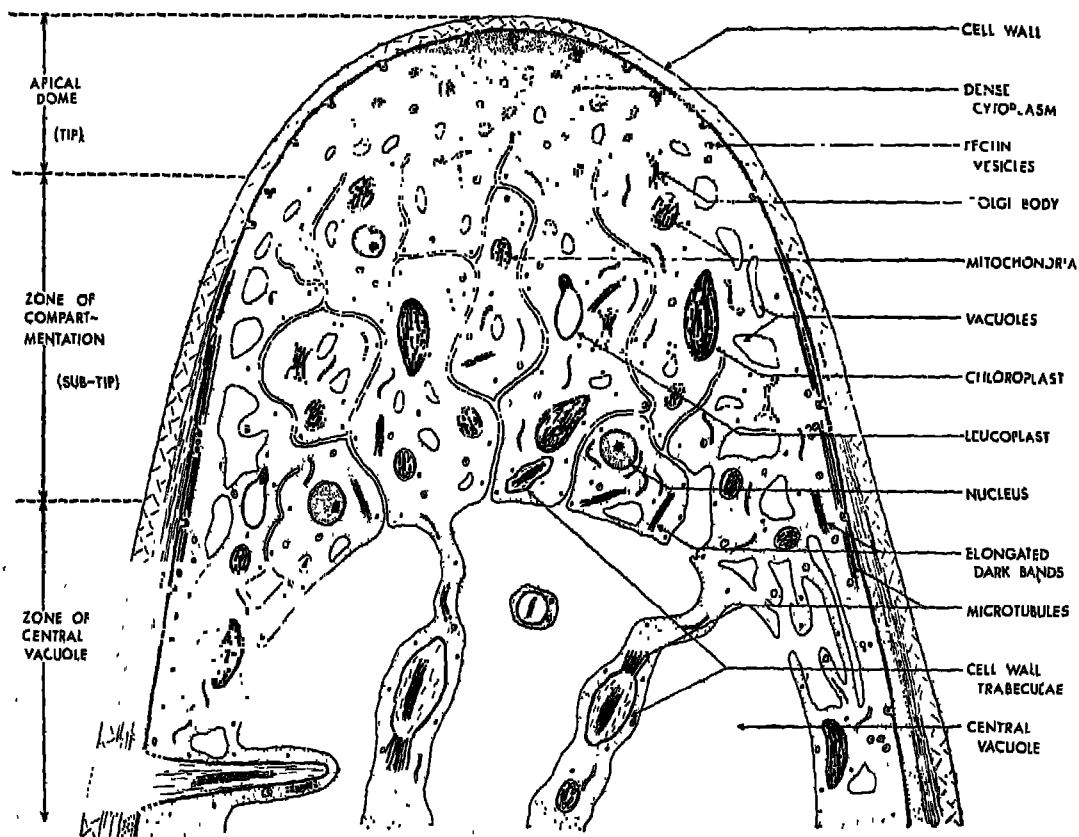


FIG. 2. When the cells elongate the plants grow. But the cell elongation is a complex process which has intrigued the plant scientists for a long time. The understanding of plant growth naturally involves the understanding of the intricate mechanism of all the organelle function such as chloroplast, mitochondrion, cell membrane, nucleus, ribosomes, Golgi apparatus, microtubules and often the generally ignored structures such as the cell wall and vacuole. The figure shows apical growth zone in the coenocytic alga *caulerpa* along with the associated cell organelles.

## CELL BIOLOGY AS 'FUNCTIONAL KNOWLEDGE'

*Trends in Education*

The launching of the new 10+2 pattern of school education has brought out a number of 'key-notes' for curriculum planners in the country. One could select a different set of 'key-notes' for different disciplines, different stages, approach, implementation, etc. but a few important ones which will be taken into account here are as follows:

1. Needs, aspirations and demands of the modernizing egalitarian society.
2. Socio-economic conditions of our society.
3. Modern knowledge.
4. Scientific method of enquiry.
5. Awareness to certain quantum of science and technology.
6. Education system to fit its surroundings.

There could be no doubt that the 'foundation stones' to lay in the teaching of cell biology must be sought and justified in terms of the keynotes and phrases mentioned above. Unless there is a legitimate justification for the inclusion of this sub-discipline it will not be able to withstand the forces of criticism which may come from the agencies whose familiarity with this new but important sub-discipline of biology is limited and which is likely to interpret the keynotes for the sake of its minimization or exclusion. Such a situation would damage no one but the country as will be evident from the discussion that follows. The difficulties in its inclusion, of course, will be genuine but solutions have to be found which are far from escapism.

It may also be mentioned here that the principles and policies available to this date refer only to the first ten years of education.

While no reversal on these keynotes should be anticipated it may be noted that the +2 education in biology as an elective subject must also aim at providing better appreciation for the horizons of modern biology and its potentialities since the student offering these courses would constitute the future technical and scientific cadre in biology. Hence the foundation for the same must be adequate and sound. A "quantum of modern knowledge" has to be fed at this stage along with everything else.

*Cell Biology vs. the Trends in Education*

Recent global trends in education owe a great deal to *Learning To Be* published as an official report of Unesco Education Mission. It puts emphasis on educational system to fit its surroundings. The education, in order to be effective, must exploit the real life situations and have definite relevance to individual as part of the community he lives in. This is often taken to mean that school education should restrict itself to the things that are within the direct perception of the young learners and less and less to things which depend on abstraction of concepts at lower levels of material organization. This may be taken as more applicable to lower levels of school education but as is well known the comprehension of the world around would remain largely incomplete without the familiarity with atomic and molecular structure of non-living matter and molecular and subcellular organizations and phenomena of the living matter. Seen from this point the biology of cells not only becomes a part of the environment one lives in, it also goes to meet the curiosity of the children of the age-group 10+ and allows the young mind to be trained in the process of abstraction and imagination of the unseen into building the mental models. The task of the teacher would be not only to sum

up the information but to help him develop this ability.

The question of cell biology being the essential component of any surroundings can be argued with numerous examples of how learning this branch of biology would help in better knowing the individual's surroundings.

The aspects of "needs, aspirations and demands" and the 'socio-economic obligations' of this subject may be discussed together. The need of the hour not only in India but throughout the world is population, food, health and the environment. These major concerns of the humanity are not analyzed in isolation. Any attempt to go into the depth of any one problem invariably leads to the other of these problem areas. Similarly, the sovereignty of the traditional compartments of knowledge such as physics, chemistry, botany, zoology and geology also get automatically shattered in finding solution to the problems of mankind today.

In this way the socio-economic obligations of science becomes too apparent to be overlooked. As for cell biology it has been found that a well rounded course before entering biology-based professional lines and technology is highly

appreciated by the concerned specialists. Those who are aware of the recent trends of questions for entry examinations of medical colleges or National Science Talent Search would agree that definite 'need' and 'demand' exist for a reorganization of biology subject-matter in favour of cellular aspects for academic as well as professional lines of biology. Cell biology has its own contributions in solving the problems of food, over population, health and environment and in providing a better future for us.

"Awareness to certain quantum of science and technology", "modern knowledge" and "scientific method of enquiry" are closely linked ideas of our "curriculum to be". The body of the syllabus in cell biology course of secondary classes provides the desired quantum of information carefully selected to represent the latest in principles and underlying scientific methodology. Acquaintance with the methodology of cell biological research brings out commonness of the broad philosophy of science. Similar research techniques may be used to solve the problems in life sciences and the physical sciences.



## T.H. Huxley on Teaching of Science in Schools

S.P. SINGH

*Department of Education, Kamla Nehru Institute  
of Science & Technology, Sultanpur*

THOMAS HENRY HUXLEY (1825-1895) was an eminent writer, teacher, speaker, biologist and educationist of his time. He was a member of the London School Board and made a deep impression on the foundation of national elementary education. Huxley's contributions to the English system of education, and science education in particular, cannot be ignored as it was he, who made the people realize that real education comes from the facts of nature and the knowledge of natural sciences is essential for achieving education in the real sense.

So far as the introduction of science in English Schools is concerned, the period of Huxley may be taken as a time of transition. In his early days science was considered to be a subject for certain professional workers and not for the education of a child. The advocates of science education were vehemently opposed by the educationists of the time. The former strong faith in classical education, i.e. instruction in Latin and Greek. To them, science

education lacked in cultural values and as such had no place in the curriculum.

Huxley made it clear that the kind of education the students were having was not worthwhile and explained lucidly that learning and knowledge were two distinct things and that the textbooks were not the only source. According to him, study of things in nature, could bring real knowledge to the child, and science is the subject which provides the direct and fruitful contact with nature. He did not take a narrow view of science, as he says:

that which I mean by 'science' is not mere physical science but all the result of exact methods of thought whatever be the subject matter to which they are applied...<sup>8</sup>

He wanted to harmonize literary and scientific education, because exclusive scientific or literary training was bound to develop a bias. Besides the cultural value of science education he emphasized its mental disciplinary aspect by giving four methods of teaching science. According to him science is nothing but trained and organized common sense; and that training of mind is in relation to the methodical teaching. In his words:

"The subject-matter of biological science is different from that of other sciences, but the methods of all are identical, and these are:

- (i) Observation of facts—including artificial observation which is called experiment.
- (ii) Comparison and Classification—general propositions.
- (iii) Deduction—which takes us from the general proposition to facts again.
- (iv) Verification—which is the process of ascertaining whether, in point of fact, our anticipation is a correct one"<sup>9</sup>.

Speaking in favour of the utilitarian value



of science, he said that "applied science is nothing but the application of pure science to particular classes of problems."<sup>8</sup> And to make sure of the acquisition of the knowledge of applied science the teaching of science based on observation and reasoning was a prerequisite.

He advocated biology teaching not because he himself was a biologist, but because the science offered same advantages as those of the other physical and chemical sciences.

"Education", as conceived by Huxley, "is the instruction of the intellect in the laws of Nature..."<sup>8</sup> Anyone who could not learn the laws of nature was bound to suffer. Hence, he had a wide concept of liberal education and provided due place to natural sciences because to him, science had the potentiality of providing the required instruction. Scholastic training in his opinion, was not sufficient; that is why he writes: "I do not mean that every schoolboy should be taught everything in science . . . What I mean is, that no boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined, more or less, in the methods of all sciences,"<sup>9</sup> because they will be able to solve the problems "by being familiar with the general current of scientific thought and by being able to apply the methods of science in the proper way..."<sup>10</sup>

It is evident that Huxley did not want to provide an intensive specialized course in science. His aim was to train the child in "the scientific habit of mind". Therefore, he recommended the teaching of science from an elementary stage because the child seeks information about the matters of physical science as soon as he begins to talk. He says: "A panoramic view of Nature, accompanied by a strong infusion of the scientific habit of mind, may thus be placed

within the reach of every child of nine or ten." He preferred the use of a German word—'Erdkunde', meaning earth knowledge—for the course of elementary science, i.e. knowledge of the earth—what is on it, in it, and about it.<sup>9</sup>

After this training with a foundation of three R's he recommended the instruction of physical sciences. Here he classified two types of physical science (all the sciences): (i) regarding form and the relation of forms to one another and (ii) regarding causes and effects. He advocated the teaching of those subjects which could provide both kinds of knowledge. He wanted botany, physical science, chemistry and human physiology to be taught in the schools at this early stage. Huxley was of the opinion that only those subjects should be taught to a student which help or provide mental discipline, acquirement of knowledge and are of practical importance. But, he urged: "the need for scientific education is demonstrable by cogent arguments belonging to all these classes."<sup>11</sup> For the first four years he suggested an obligatory course of elementary science for all the scholars. After this preparatory course he offered three groups in science and one in social science (which he takes as science) and left the student free to select according to his own interest.

Huxley's view on the curriculum was very critical and liberal. He wanted that the school curriculum should be very wide and provide opportunities for men and women. But it did not mean that there should be too many subjects in the curriculum; he said, "the aim should be the attainment of a thorough and sound knowledge of each (subjects)".

Huxley, as a teacher, set an example in the field of science teaching. He was opposed to the bookish knowledge and prevalent way of teaching. Huxley was of the view that 'autho-

city' in science teaching was bad. He claimed that it is "the pupil's duty to doubt". During teaching the mind of the student should be brought into direct contact with the facts. According to Huxley: "If scientific education is to be dealt with as mere bookwork, it will be better not to attempt it..."<sup>1</sup> He suggested making the student see and realize the nature of the thing under discussion and let him interpret by inductive and deductive reasoning. He believed in practical teaching, reading of books, and hearing of lectures as the three best ways for a thorough grasp of the subject, and accordingly suggested that this method be adopted for the subjects of science. His own teaching of the general principles of biology in South Kensington was the height of pedagogy. Teaching for purely commercial ends was not, in any way, liked by him. He developed the type form of teaching in biology. He used to select a representative animal of a group or class as a type form and would give a thorough knowledge of the foundation of morphology. Students were given these type animals to observe directly in the laboratory. Huxley's belief in this "type" of syllabus as a practical means of bringing all the aspects of zoology to science classes, was expressed in these words:

....I should select a freshwater polyp or a

Cyanae, a freshwater mussel, a lobster, a fowl as types of five divisions of the animal kingdom. I should explain their structure very fully and show how each represented the great principles of zoology. Having gone very carefully and fully over this ground, I should feel that you had a sound foundation, and I should then take you in the same way, but less minutely, over similarly selected illustrative types of the classes; and then I shall direct your attention to the special forms enumerated under the head of types, in this syllabus, and to other facts there mentioned.<sup>5</sup>

This is sufficient to explain why Huxley laid greater emphasis for a museum in every school, particularly in biology teaching.

The above discussion reveals a fair picture of Huxley's views on science, its content, and methods of teaching. That the introduction of science into English schools was the direct result of the efforts of Huxley is not an exaggerated statement, in the context of his great war against traditionalism. Biology in particular owes a great deal to Huxley's contribution; which not only made claim for its position in the curriculum but established an equal relationship of this branch with other branches of science.

#### REFERENCES

1. *Dictionary of National Biography*, Vol. XXII, Supplement, p. 806
2. *Encyclopaedia Britannica*, Vol. II, p. 916
3. CYRIL BIBBY, *T. H. Huxley, A Scientist, Humanist and Educator*, 1959
4. THOMAS H. HUXLEY, *Science and Education : Essays*, Macmillan and Co., London, 1925
5. —, *A Liberal Education, And Where to Find it*, 1868
6. —, *On the Educational Value of the Natural History Science*, 1854
7. —, *On the Study of Biology*, 1876
8. —, *Science and Culture*, 1880
9. —, *Scientific Education : Notes of an After-Dinner Speech*, 1869
10. —, *Lay Sermons, Address and Reviews*, 1869, p. 105

# Transfer Technology Related to School Science Equipment

A. P. VERMA

*Workshop Department, NCERT, New Delhi*

THE WHOLE range of technical inputs other than the raw materials and labour which go into such economic activity, in particular the process, machinery, equipment and tools for each segment of production may be referred to as technology. Technology may be defined as the means or capacity to perform a particular activity. On the problem of technological application found in the country the following picture will be found. There is a certain kind of indigenous technology rooted within the country. On the other extreme end there will be found the utilization of most advanced technologies. In between these two extremes are all kinds of possibilities which also found its way towards utilization either as a historic process of careful considerations. In this way technology is brought closer in the realm of the production function and using the various degrees of mixes of the production factors, classification to what kind of technology, i.e. advanced, intermediate or low technology will be possible.

What is meant by "Transfer of Techno-

logy"? The word transfer implies the existence of a source and recipient while something is passed between them through appropriate communication channel. What is really passed on to the recipient by the source is the technical know-how and its associated tools.

The source is associated with the ownership of the know-how, while the recipient is the one who sees the need of that particular know-how towards its utilization in order to fulfil his desired ends. The transfer of technology therefore means the utilization of existing techniques in an instance where it has not been previously used. This transfer may be merely the acceptance by a user of a practice common elsewhere or it may be a different application of a given technique designed originally in another use. The acceptance by a user of a common practice is called adoption and the spread of such adoption is called "diffusion of technology".

The Central Science Workshop (now renamed as the Workshop Department), a constituent unit of NCERT was established in 1964 on the basis of the recommendation of the Unesco Planning Mission. The Workshop Department acts in close cooperation with the Department of Education in Science and Mathematics (DESM). With a view to re-organizing and expanding the teaching of science to as many students as possible throughout the school stage, in order to develop the scientific attitude of the students, a project known as Unicef-assisted Project has been launched. Unesco has already provided assistance in the shape of equipment for laboratories and work-

---

\*The author is grateful to the Department of Education in Science and Mathematics, NCERT, and the Unesco/Unicef experts who assisted the Workshop Department in this project and gave valuable suggestions and guidance.

shop, foreign expertise and training facilities abroad for Indian counterparts under the Secondary Science Teaching Project for developing an up-to-date and upgraded curriculum for science and mathematics for the school stage.

The main objective of the project is to upgrade and update the teaching of science throughout the school stage and to ensure the active participation of the student in the teaching-learning process by providing first-hand science experiences. This is to be achieved by involving children in doing experiments and discovering the various facts, laws and generalization for themselves.

There is a greater emphasis on the "process" of science rather than on the "product" of science. The learning is mainly through a series of connected activities by the children, the teacher or both, with simple materials, suitable apparatus which have been improvised using indigenous materials and have been collected and organized in the form of a science kit. The purpose is to raise a problem situation where the child does some activities, investigates and arrives at the answer with his own efforts rather than simply being given the cold factual information. The idea is not to make the child to memorize but to develop his thinking and reasoning.

The DESM surveyed the existing pattern in the various states and planned a project which is financed by the Union Ministry of Education, Unesco and the Unicef. The Department developed a new curricula which included a compulsory course of science and mathematics. The national instructional material developed for teaching science envisage the need of various equipments including the science kit. The responsibility of improvising the laboratory equipment was given to the

Workshop Department.

The main emphasis of the project is on learning science by doing which gives a key role to the improvised apparatus. In developing the new aids for the Indian schools a study was made of many foreign samples and catalogues and the following necessary requirements were considered which the audio-visual aids should meet.

1. To clarify and present correctly and scientifically the laws and phenomena for the study of which they were developed.
2. to ensure a high degree of clearness of perception.
3. The aids should be of such a size that would enable the teacher to demonstrate them easily and allow good visibility for the students.
4. The aids should be cheap.
5. The aids should be manufactured from the indigenous material and rarely with the use of imported half-finished products.
6. The aids should be simple, durable and reliable.
7. They should be convenient to use.
8. To ensure the performance of several experiments with the help of one device using a complimentary set of parts.
9. To arouse students' interest and activity.
10. The performance rating, i.e. pedagogical output in proportion to the cost of equipment should be maximum.

In order to implement this new methodology in the classroom, suitable apparatus has been improvised using indigenous materials and has been collected and organized in the form of a

science kit. These kits are portable and act as mini laboratories, suitable for use even in an ordinary rural school where separate science rooms or conventional laboratories are not available. The cost has been kept low by utilizing locally available material. The items are simple in operation and sturdy in construction so that the children can use them without any fear of damage. These kits provide the following additional advantages.

- (i) Availability of necessary items at one place.
- (ii) Multipurpose use of items.
- (iii) Economy of time in setting up.
- (iv) Economy of consumable materials.
- (v) Portability from one room to another.
- (vi) Provision for teacher's innovation.
- (vii) Low cost and use of indigenous resources.
- (viii) Easy replacement of lost or broken items.

#### *From a Laboratory Prototype to an Industrial Prototype*

The stages of prototype development through which an experiment has to pass, in order to take the shape of an industrial prototype, is given below:

1. The science experts give the idea of the apparatus conceived, the experiment to be performed and the results expected.
2. The technical experts prepare the drawing/sketch of the prototype to be made.
3. The laboratory sample of the prototype is prepared.

4. There is a group discussion on the prototype involving both the scientist and the engineer to evaluate and approve the prototype.
5. A second prototype sample may be necessary in view of the changes suggested.
6. The working drawings/manufacturing drawings, giving complete specifications, international standards, list of materials, etc. is prepared.
7. The description of the items to be included in the kit guide is prepared.
8. The technological process involving selection of machines and materials is made.
9. The planning and scheduling of the prototype is done and target dates are fixed.
10. The press tools and other tools and the dies for plastic, etc. are prepared.
11. The prototype is produced.
12. The control for quality is introduced at stage level and also performance tests are prescribed. Statistical quality control checks are prescribed.
13. An experimental batch of about 40-50 pieces is prepared and is taken to the field for a try-out.
14. After the feedback has been received, they are analysed and the suggestions/modifications are incorporated in the design of the prototype. The complete manufacturing drawings along with necessary specifications is drawn up. In the process 1 to 14, about one year is spent.

### *Model of Mass Production*

To explain how a prototype is conceived, developed, field-tested, evaluated and finally produced, a schematic diagram of operations is shown in Appendix 1.

### *Science Kits*

The following primary and middle school science kits have been developed and produced by the Workshop Department.

#### PRIMARY SCIENCE KIT

The kit itself is a complete mini laboratory. It is handy and portable. It contains 76 items and most of them can easily be procured locally. The built-in collapsible table and chalk-board make the kit a self-sufficient unit. The kit has

also been provided with ten hand tools beside the consumable materials, chemicals and a set of instructional charts and sketches. This kit can be used for the entire period of primary schooling. The hand tools provided with the kit help the teacher in fabricating some improvised apparatus or undertaking some minor repairs of the kit and of the apparatus.

#### PHYSICS (PART I KIT)

This kit has been designed and developed for the first year of the middle school. It is a complete laboratory in a wooden box having five trays and containing about 85 items. This kit helps the teacher in performing the demonstrations in these fields: (i) introduction to physics, (ii) measurement, (iii) force, weight

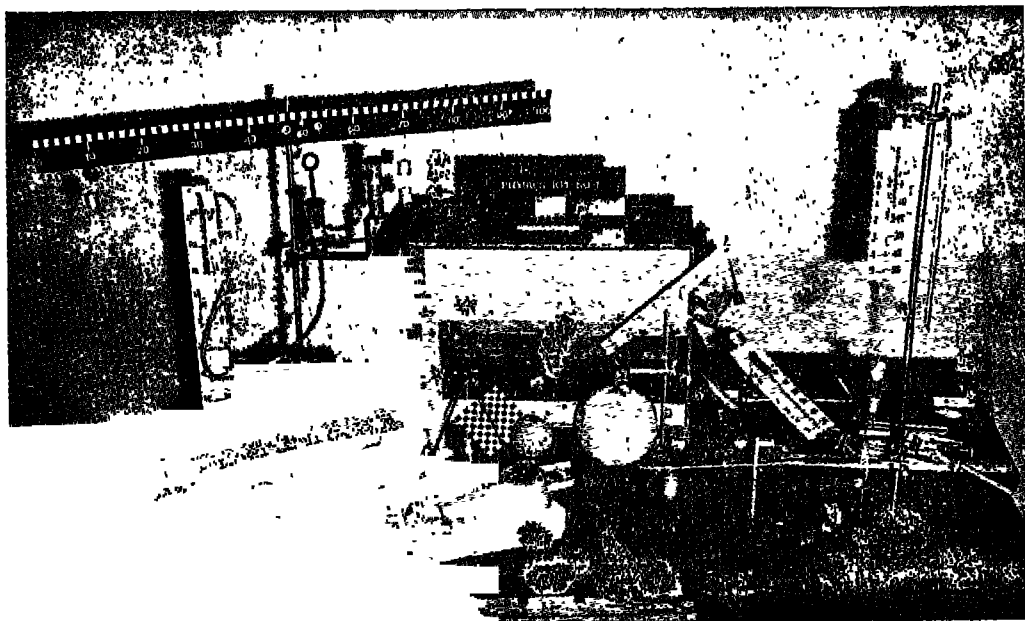


FIG. 1. Physics (Part I Kit)

and pressure, (iv) structure of substances, and (v) the pressure in liquids.

### PHYSICS (PART II KIT)

This kit has been developed for the second year of the middle school. The kit is portable and two students can easily carry it from one class to another as and when desired by the teacher. It contains 64 items including the kit box. The items are housed in the four apartments of the kit. It helps the teacher in giving demonstrations in the following fields during the actual process of teaching in the class :

- (i) Composition of forces, equilibrium of bodies;

- (ii) Work and energy;
- (iii) Thermal phenomena;
- (iv) Heat and work;
- (v) Transition of substance from one state to another;
- (vi) Sound.

### PHYSICS (PART III KIT)

It is last in the series of science kits developed so far and also completes the set of physics kits for the three years of the middle school stage. This kit is used in the final year of the middle school. It contains 76 items which are stored in five different compartments of the kit. The main feature of the kit is smoke chamber ray box. The smoke inside the box helps

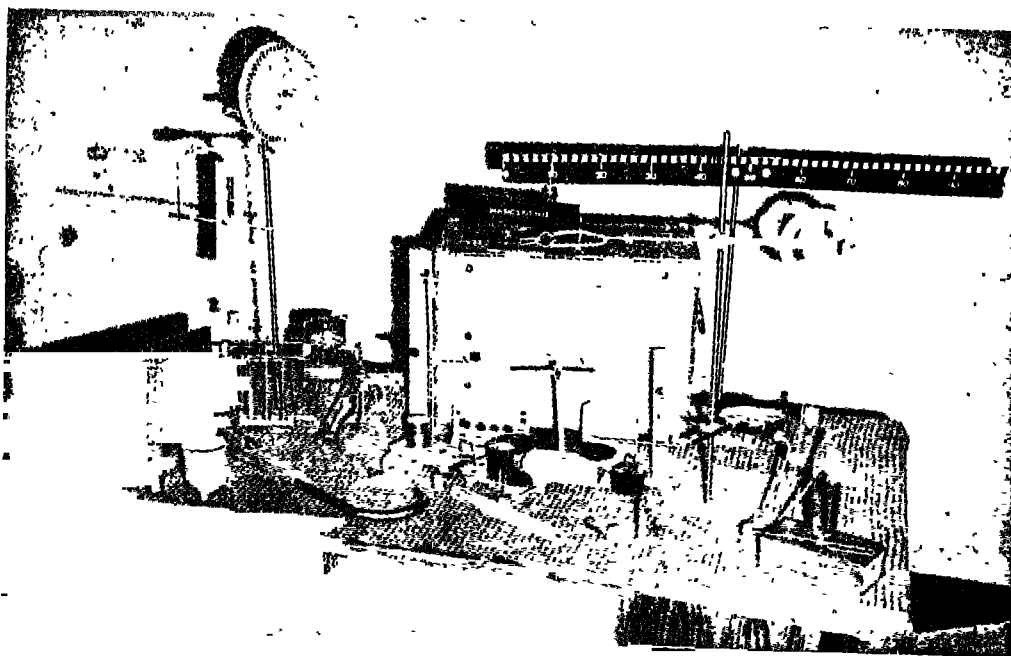


FIG. 2. Physics (Part II Kit)

in making the path of the ray visible to the students and thus helps them understand the optics in a better way. With the help of these kit-items the experiments in the following fields can be demonstrated to the students : (i) Optics, (ii) Electricity, and (iii) Magnetism.



FIG. 3. Trolleys

### CHEMISTRY KIT

The chemistry kit has been designed and developed for the second and third years of the

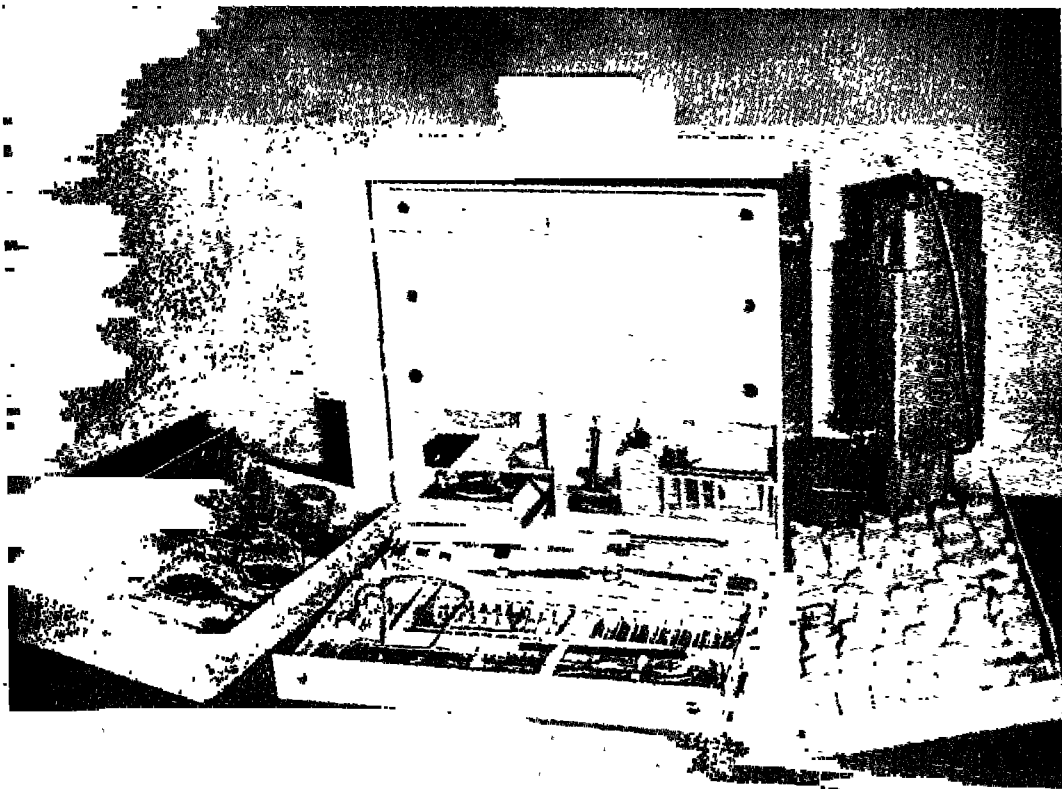


FIG. 4. Chemistry Kit for Middle Stage



middle school. The kit itself is a complete chemistry laboratory. There are four compartments in the kit containing glass wares, chemicals, heating devices, improvised apparatus and other general items. The kit has 128 items. The kit items help the teacher in giving the demonstrations in the following areas :

1. Substances and the changes that take place in them;
2. structure and composition of substances;
3. oxygen, air;
4. hydrogen;
5. water and solutions;

6. important class of inorganic compounds;
7. chemistry in agriculture;
8. carbon and its compounds;
9. metals;
10. the importance of chemistry in national economy and the development of chemical industry in India.

#### BIOLOGY (PART I KIT)

It is the first kit developed in the biology series. It is meant only for the first year of the

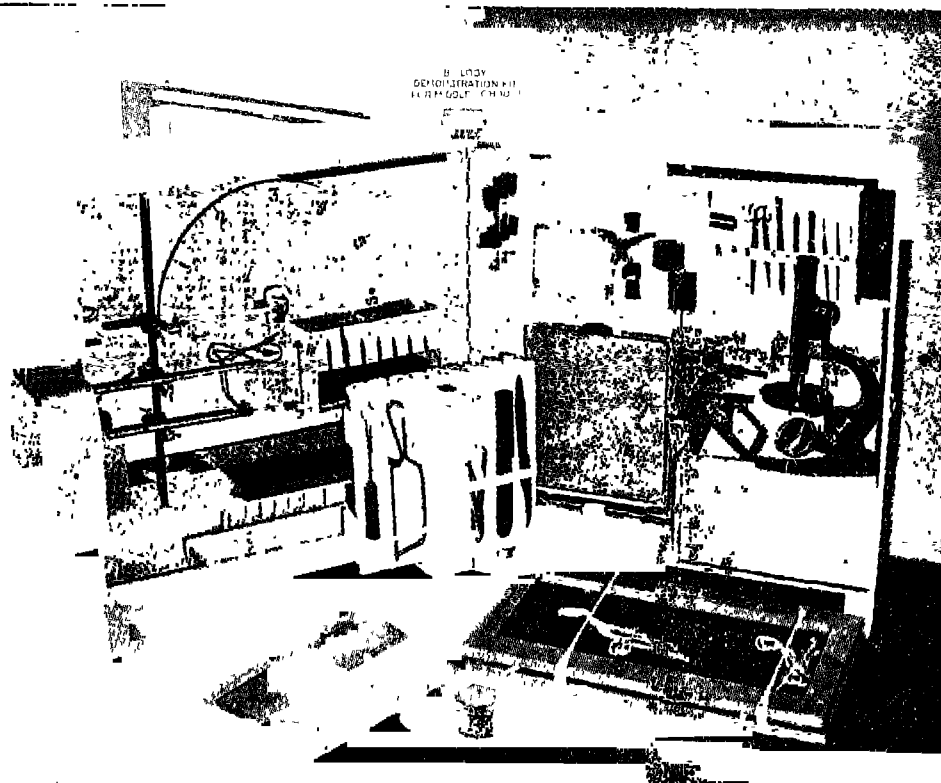


FIG. 5. Biology Kit for Middle Stage

middle school stage. It contains only 17 items. The 16 items are kept in one of the items named heliotropic chamber forming the kit. This kit helps the teacher in performing the experiments in the field of botany only.

#### BIOLOGY NON-COMPOSITE

This kit was developed and supplied to those consignees to whom the Biology Part I kit was supplied earlier. It contained 59 items only. This kit helped in covering the areas like zoology and physiology. These two kits when combined thus could cover the three years of middle school stage.

#### BIOLOGY COMPOSITE

The word composite itself makes it clear that a single kit has been designed in such a way that it covers the fields of botany, zoology, physiology as were covered by the Biology Kit I and Biology Non-Composite Kits separately. It covers all the three years of the middle stage. It has four compartments and contains 68 items.

#### *Transfer Technology Related to Science Kit*

The complete manufacturing drawings and specifications for each item of the kit was prepared and a complete album giving complete technical know-how for each of the science kit was prepared. The quality control was given due consideration in a production process where a large number of components were to be manufactured by a number of distinct industries and these have to be ultimately assembled into kits again by a number of assemblers. It

has been suggested that there should be two-tier inspection, viz. one in the process of quality control and secondly, in the inspection of the finished goods. In the technical know-how the complete details regarding the quality control aspect are also included and these are passed on to the manufacturer who intend to manufacture these kits.

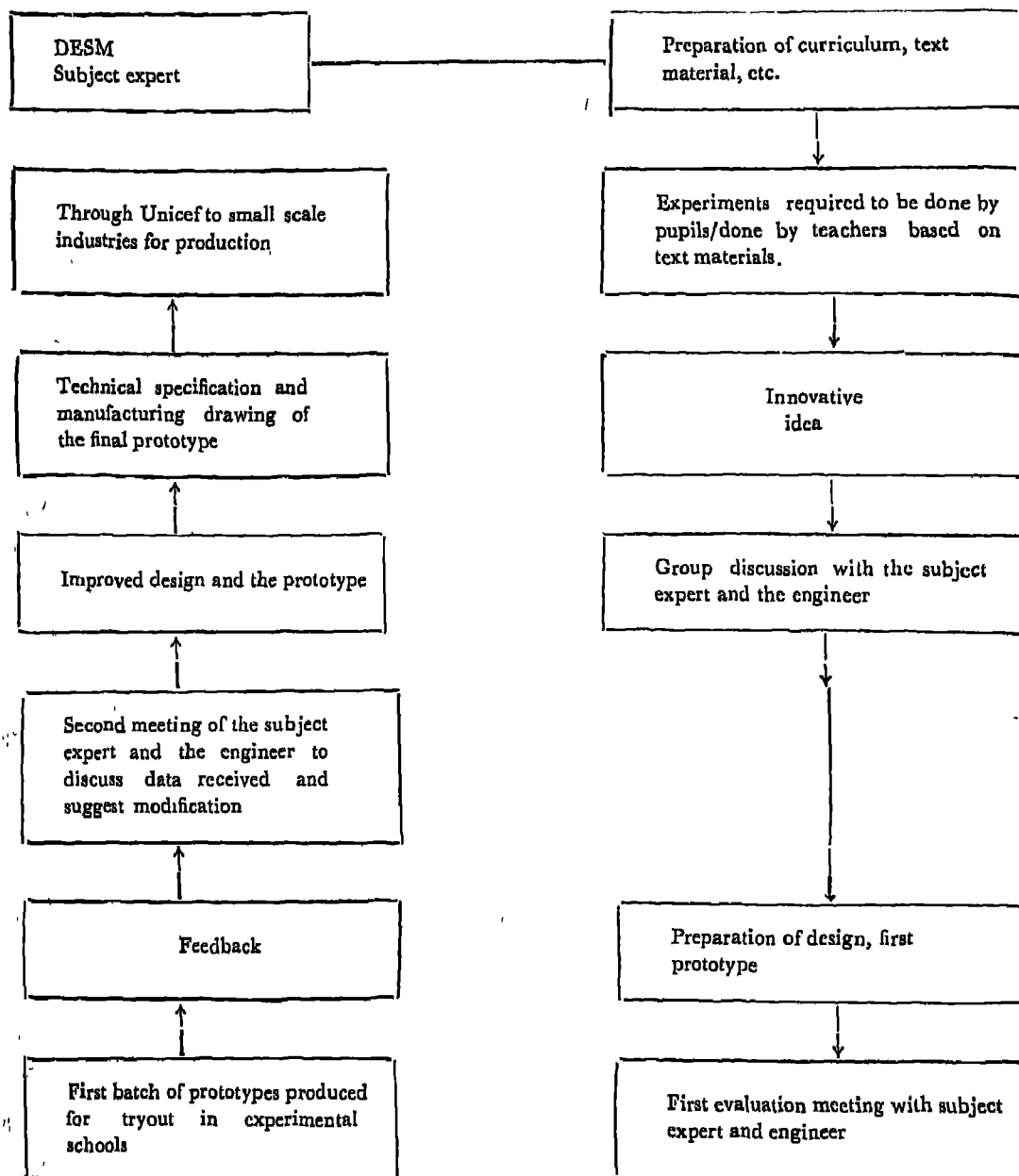
#### *Manufacturing of Kits by Small-Scale Industries*

In order to supply the kits in the wider introduction phase of the Unicef programme to the selected schools in various states, the Unicef invited tenders and on the basis of the quality and cost considerations, supply orders were placed for different types of kits on different suppliers. The complete manufacturing drawings and specifications were prepared by the Department and given to the Unicef for this purpose. The equipments provided in the kit are of different types and require various types of skills and facilities to make the same. A situation where a number of small scale industries are grouped together would, therefore, be most suitable for this type of equipment manufacture.

#### *Manufacturing of Kits on the Technical Know-how Developed in the Department*

The manufacturers of science kits have made use of the technical know-how regarding these kits which have been developed at the Workshop Department. Under wider introduction phase the Unicef is supplying a large number of science kits to the key institutions throughout the country through the manufacturers listed in Appendix 2. The names of the state/union territory which are receiving the science kits under Unicef-assisted science education programme are given in Appendix 3.

## APPENDIX 1



APPENDIX 2  
KIT SUPPLIERS AND THEIR ADDRESSES

<i>Sl. No.</i>	<i>Name of the Supplier/Address</i>	<i>Type of the Kit</i>	<i>Classes for which the Kit is Used</i>
1.	M/s Delta Laboratory Equipments 6438, Bagichi Ishwari Pershad Bara Hindu Rao, Delhi	Primary Science	III to V
2.	M/s Gaupad Chemicals Kaithal Gate Chandausi, U.P.	Primary Science	III to V
3.	M/s Optika & Chemico 28-B, Industrial Estate Gwalior, M.P.	Physics I/Physics III	VI/VIII
4.	M/s Hargolal & Sons Hargolal Building Hargolal Road Ambala Cantt.	Physics II/Physics III	VII/VIII
5.	M/s Metro Scientific Industries Mori Gate, Delhi	Physics I	VI
6.	M/s Dynam Engineering Corporation 0, Haudin Road Bangalore	Physics I	VI
7.	M/s Arun Chemicals & Scientific Industries 11/5495, Basti Harphool Singh Sadar Thana Road, Delhi	Chemistry	VII to VIII
8.	M/s Sisbro Scientific Industries (New) 47 UA, Jawahar Nagar Delhi	Biology Composite/ Biology Non-Composite	VI to VIII/ VII to VIII
9.	M/s. Mittal Sales Corporation Chand Tara Building G.T. Road, Shahdara, Delhi	Biology Composite/ Biology Non-Composite	VI to VIII/ VII to VIII
10.	M/s Gadget House Bhagat Ki Kothi Jodhpur, Rajasthan	Biology Composite	VI to VIII
11.	The Haryana State Small Industries & Export Corporation Limited Bank of India Building (2nd Floor), Sector 17-B, Chandigarh	Biology I	VI
12.	M/s Educational Kit Manufacturer 255/30 Mangal Dass Building Kitchen Garden lane, Bombay	Biology Non-Composite	VII to VIII

## APPENDIX 3

## SOURCES OF SUPPLY OF SCIENCE KITS TO STATES/UNION TERRITORIES

	<i>Primary</i>	<i>Physics I</i>	<i>Physics II</i>	<i>Physics III</i>	<i>Chemistry</i>	<i>Biology I</i>	<i>Biology Non- Composite</i>	<i>Biology Composite</i>
1. Andhra Pradesh	1	6	4	4	7	9	9	8,9,10
2. Assam	1,2	3	4	3	7	9	9	—
3. Arunachal Pradesh	1,2	5	4	3	7	9	9	8,9
4. A & N Islands	1,2	5	4	3	7	9	9	8,10
5. Bihar	1,2	6,5	4	3	7	9	9	8,9
6. Chandigarh	1	5	4	3	7	9	9	8,9
7. Dadra & Nagar Haveli	—	—	—	—	—	—	—	—
8. Delhi	1	5	4	3	7	9	9	8,9
9. Gujarat	1	3,5	4	3	7	9	8,12	8,10
10. Goa, Daman & Diu	1	6	4	3	7	9	8,12	—
11. Haryana	1	5	4	3	7	11	9	8,9
12. Himachal Pradesh	1	3,5	4	3	7	11	9	8,9
13. Jammu & Kashmir	1	5	4	3	7	11	9	—
14. Kerala	1	5	4	4	7	9	8,12	8,9
15. Karnataka	1	6	4	4	7	9	8,12	9
16. Lakshadweep	1	6	4	4	7	9	9	—
17. Maharashtra	1	3	4	3	7	9	8,12	8,10
18. Madhya Pradesh	1,2	3	4	3	7	9	8,12	10
19. Meghalaya	1	3	4	3	7	9	9	—
20. Manipur	1,2	3	4	3	7	9	9	—
21. Mizoram	—	—	—	—	—	—	—	—
22. Nagaland	1,2	5	4	3	7	9	9	8
23. Orissa	1,2	5	4	3	7	9	9	8,9
24. Punjab	1	5	4	3	7	11	9	8,9
25. Pondicherry	1	6	4	4	7	9	8,12	9
26. Rajasthan	1	5	4	3	7	9	8,12	8,10
27. Tripura	1,2	5	4	3	7	9	9	9
28. Tamil Nadu	1	6	4	4	7	9	9	8,9
29. Uttar Pradesh	1,2	5	4	3	7	9,11	9	8,9,10
30. West Bengal	1,2	3	4	3	7	9	9	9

NOTE : The numbers given in these columns refer to the serial numbers of the suppliers as shown in Appendix 2.

# Magic Squares

A. VENKATACHARLU

[The author is a retired assistant headmaster of the Christian College School, Madras. He was a popular teacher of mathematics, who encouraged his students by providing challenging mathematical activities. He has continued his interest in mathematics till today. In this article, he presents his work on Magic Squares. It is hoped that both students and teachers will find it interesting.]

## Nomenclature

1. *Magic Square*. A square divided into the equal number of small squares both horizontally (i.e. length-wise) and vertically (i.e. breadth-wise) and filled up with positive whole numbers, in such a way that when the numbers in the different rows—vertical, horizontal and diagonal—are added, the same sum is obtained. While filling the small squares, no number should be repeated.

2. *A house*: Each small square is called a house.

3. *Horizontal and vertical rows of houses*: Houses lying in the same horizontal row, running from

the left to the right, form a horizontal row of houses. Houses lying in the same vertical row, running from top to bottom, form a vertical row of houses.

The horizontal rows of houses are numbered from top downwards and the vertical rows of houses are numbered from the left to the right.

The houses themselves are numbered from left to right starting from the first horizontal row of houses and in the same order down to the end of the last horizontal row.

*Note*: Any corner house may be called House 1 and the numbering may proceed in either direction from this house.

The different ways of numbering in a four-house squares are shown on the next page.

4. *A series*: An arithmetical series is in short called a Series (Later, what I prefer to call a compound series is introduced).

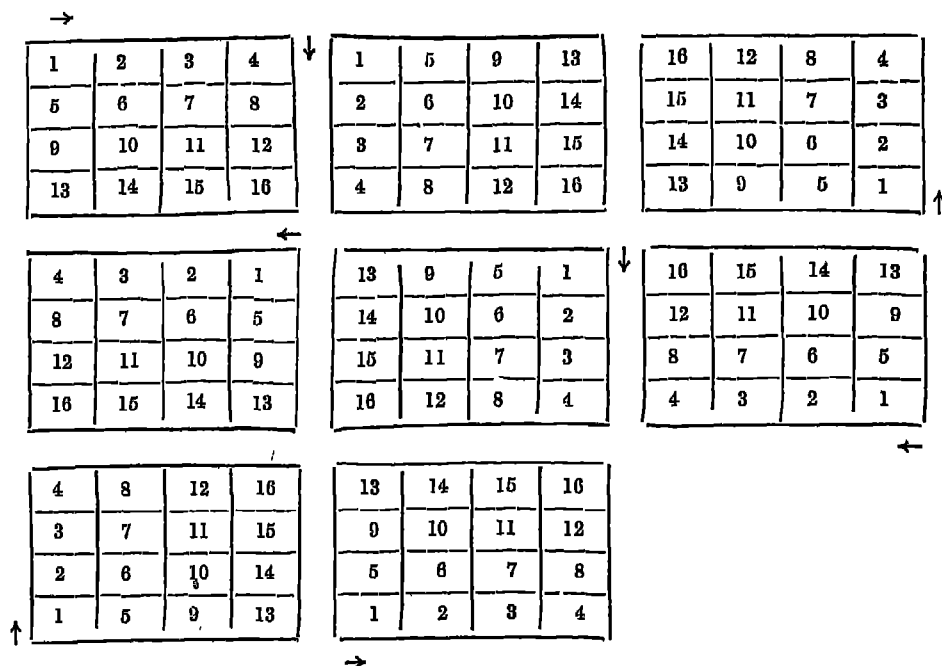
## PART I

The rules for filling up a magic square with an odd number of houses each way:

*Selection of Series*: (1) It may be the one consisting of natural numbers starting with any number, e.g. 5,6,7,8,.....(It may be in descending or ascending order).

(2) It may be an arithmetical series with any common difference (C.D.) taken in either ascending or descending order, e.g. 5,8,11,14... or 20,18,16...

(3) If it is a 'n' house square it may be 'n' sets of 'n' numbers of 'n' different series, the C.D. being the same in ALL and the 1st numbers of these n series forming a different series with a different C.D. For example, let us take a 5 house square. The numbers chosen may be 2,5,8,11,14; 7,10,13,16,19; 12,15,18,21,24; 17, 20,23,26,29; 22,25,28,31,34.



*Note:* The C.D. in each of the five sets in 3, and the first numbers of these sets form a different series with C.D. of 5.

(This is what I call a compound series)  
(While using these, they should be used in order).

#### *Rules for Filling the Squares*

*Method 1.* Let us take the above compound series.

1. Enter the first number of the chosen series in the central house of the lowest horizontal row of houses.

2. After an entry move down diagonally to the right. While moving down diagonally you may (a) go out of the square and be in the line of a vertical or horizontal row of houses; (b) go out of a corner; (c) go into an empty house, and (d) go into a house which is filled up.

12	23	34	5	16
10	15	26	22	8
11	7	18	29	25
28	14	10	21	17
20	31	2	13	24

If you go out of the square, and are in a line with a row of houses, enter the next number in the house at the far end square of this rows of houses.

If you go out of a corner or into a house which has been filled up, enter the next

number in the house just above the house you last filled up.

If you go into a vacant house, enter the next number there.

*Note:* (i) You may begin in the central house of any one of the other three last rows of the houses.

(ii) Go diagonally to the left.

If you do so, you must adopt the other rules accordingly.

(iii) Horizontal rows at equal distances from the central row may be interchanged.

Vertical rows at equal distances from the central row may be interchanged.

Or both.

*Method 2.* (1) Enter the first number of the series in the house just below the central house.

(2) Go down diagonally to the right. (Note: you may go to the left also).

(3) If you go into a vacant house enter the next number there.

(4) If you go out of the full square, enter the next number in the house at the other end of the row of houses.

(5) If you go into a house which has been filled up, enter the next number in the house two houses below the house you last filled up and enter the next number there and if this is not possible go (n-2) houses above the house you last filled up, and enter the next number there.

(6) If you get out of a corner, go (n-2) houses above the house you last filled up and enter the next number there.

You may start with the house just above the central house or to the right or left of the central house. But you must adopt the rules accordingly.

*An Example:* Let us take a 7-house square and the following compound series.

1, 3, 5, 7, 9, 11, 13; 8, 10, 12, 14, 16, 18, 20; 15, 17, 19, 21, 23, 25, 27; 22, 24, 26, 28, 30, 32,

34; 29, 31, 33, 35, 37, 39, 41; 36, 38, 40, 42, 44, 46, 48; 43, 45, 47, 49, 51, 53, 55.

22	51	17	46	12	41	7
9	24	53	19	48	14	29
31	11	26	55	21	36	16
18	33	13	28	43	23	38
40	20	35	1	30	45	25
27	42	8	37	3	32	47
49	15	44	10	39	5	34

This method is the same as shown below by a 7-house sq. with natural numbers.

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49

#### Rules Followed

Write down the series chosen in order to form a seven-house square (no sq. is drawn).



Draw lines diagonally both ways as shown. Find out the central house formed by the rows. Keeping this as the central house of the Magic Square (25 is in the central house) mark the Magic Square.

In a line with the central house with 25 you find 1 and 49 outside and two vacant

houses inside. Count 7 houses (change this according to the number of the houses in one line of the M.S) along the row in which 1 is situated and enter it there. Similarly enter all the other numbers found outside the square in the 7th house counted from the house in which it is placed.

*A 9-house square with algebraic symbols*

$a+4c$	$a+5c+2d$	$a+6c+4d$	$a+7c+6d$	$a+8c+8d$	$a+d$	$a+c+3d$	$a+2c+5d$	$a+3c+7d$
$a+3c+8d$	$a+4c+d$	$a+5c+3d$	$a+6c+5d$	$a+7c+7d$	$a+8c$	$a+2d$	$a+c+4d$	$a+2c+6d$
$a+3c+7d$	$a+3c$	$a+4c+2d$	$a+5c+4d$	$a+6c+6d$	$a+7c+8d$	$a+8c+d$	$a+3d$	$a+c+5d$
$a+c+6d$	$a+2c+8d$	$a+3c+d$	$a+4c+3d$	$a+5c+5d$	$a+6c+7d$	$a+7c$	$a+8c+2d$	$a+4d$
$a+5d$	$a+c+7d$	$a+2c$	$a+3c+2d$	$a+4c+4d$	$a+5c+6d$	$a+6c+8d$	$a+7c+d$	$a+8c+3d$
$a+8c+4d$	$a+bd$	$a+c+8d$	$a+2c+d$	$a+3c+3d$	$a+4c+5d$	$6+5c+7d$	$a+0c$	$a+7c+2d$
$a+7c+3d$	$a+8c+5d$	$a+7d$	$a+c$	$a+2c+2d$	$a+3c+4d$	$a+4c+6d$	$a+5c+8d$	$a+6c+d$
$a+6c+2d$	$a+7c+4d$	$a+8c+6d$	$a+8d$	$a+c+d$	$a+2c+3d$	$a+3c+5d$	$a+4c+7d$	$a+5c$
$a+5c+d$	$a+6c+3d$	$a+7c+5d$	$0+8c+7d$	$a$	$a+c+2d$	$a+2c+4d$	$a+3c+0d$	$a+4c+8d$

Initial number is 'a'

C.D. throughout is d.

C.D. between the numbers of the 9 sets = C

Sum =  $9a+3d+36c$

Method 1 is followed. Method 2 may also be tried.

*Something Interesting*

In the 1st Magic Square above, (1) the number in the central house 18 multiplied by 5,

the number of houses each way gives 90, which is the sum of each line.

2.  $12+24=36$ . Now go round say, in the clockwise direction starting from  $12+24$ : In the next stage are 23 and 13 which when added gives 36. Trace similar results in the next inner round. 36 is also  $2 \times 18$ , i.e. twice the number in central square.

In the second filled-up 'magic square find out similar results.  $\square$

## Around the Research Laboratories

### Central Potato Research Institute, Simla

SURESH JAIN

*Department of Education in Science and Mathematics,  
NCERT, New Delhi*

THE Central Potato Research Institute was established at Patna, Bihar, in 1949, to carry out research on all aspects of potato in India. Simultaneously, the Potato Breeding Station at Simla, the Seed Certification Station at Kufri (Himachal Pradesh), which were previously under the control of the Indian Agricultural Research Institute, New Delhi, were transferred to this Institute. The headquarters of the Institute was shifted from Patna to Simla, Himachal Pradesh, in 1956.

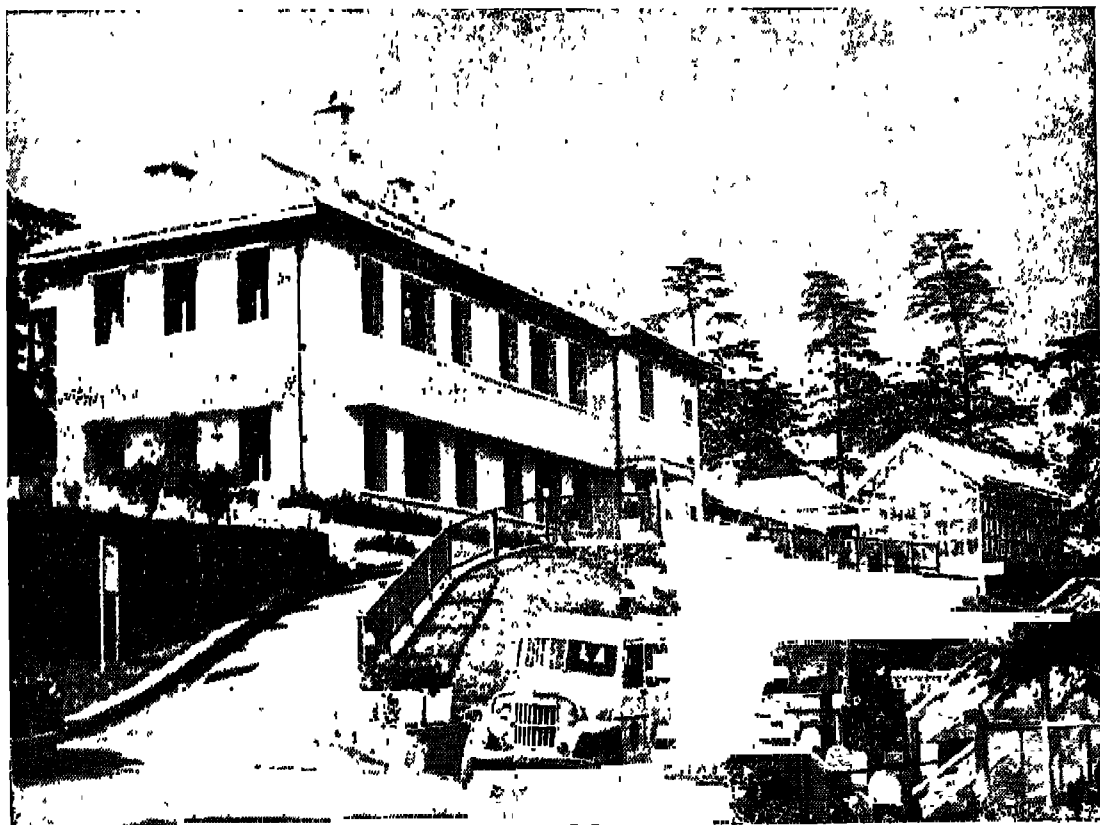


FIG. 1. The main building of the Central Potato Research Institute, Simla

The Institute at Simla with its laboratories, glass-houses, a small library and terraced experimental plots is situated (Fig. 1) about 4 km from the Simla railway station. The farms attached to the main Institute and the regional centres cover an area of 230 ha.

### OBJECTIVES

The Institute and the regional stations are engaged in multi-disciplinary research on the following aspects of potato crop: (i) breeding and selection of high-yielding and disease-resistant varieties suited to different agro-climatic conditions in the country; (ii) determination of optimum standards of cultivation in relation to soil-climate complex; (iii) survey and investigation of major diseases and pests of potato, both in the field and storage and development of control measures; (iv) investigation of problems connected with dormancy, control of sprouting and storage; and (v) standardization of techniques of production of disease-free breeder's seed.

The Institute is also concerned with the production of substantial quantities of breeder's seed for supply to the states for multiplication, the training of state personnel and growers in the improved methods of potato cultivation, and the dissemination of results of research to the extension agencies.

### ACHIEVEMENTS

#### A. Potato Breeding

**VARIETAL IMPROVEMENT:** Research on genetic improvement has resulted in the evolution of some high-yielding varieties with desirable attributes to suit the varying agro-climatic

conditions. An outstanding achievement of the Institute is the evolution of varieties resistant to late blight (potato disease). These varieties remain green for about four weeks after the commercial varieties succumb to the attack of the disease. Among the blight-resistant varieties special mention may be made of 'Kufri Jyoti' and 'Kufri Jeevan' released for cultivation in

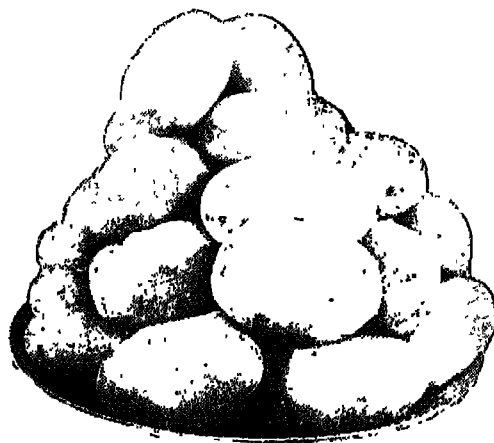


FIG. 2. An improved variety of potato *Kufri Jeevan*, developed at the Institute

Himachal Pradesh; 'Kufri Naveen' and 'Kufri Khasigaro' for the Assam Hills; and 'Kufri Neelamani' for the Nilgiri Hills. 'Kufri Chandramukhi' is an early variety, bulking up rapidly and has become popular in areas where it can be easily cultivated by the multiple-cropping systems or where the growing season is short. 'Kufri Alankar' is another early variety. 'Kufri Sheetman' has been released for the areas (Punjab and neighbouring parts) susceptible to frost. 'Kufri Chamatkar' and 'Kufri Sindhuri' medium-to-late-maturing varieties, have proved as main varieties of potato crop in areas with longer growing season, as in the plains of Uttar Pradesh and Bihar.

Two wart-resistant varieties, 'F 5242' and 'F

3977', have been selected for further trials. Sources of resistance to root-knot nematode and golden nematode have also been located.

### *B. Seed-plot Technique*

The studies by the regional stations on the appearance and build-up of aphid (Arthropods) population have revealed the safe period of low aphid incidence in the plains and led to the evolution of seed-plot technique. The technique consists of starting with disease-free seed, growing it during low aphid periods in October-to-December in the sub-tropical plains of northern India, killing the above-ground vegetative parts of crop by the end of December before aphids build up, and lifting the tubers as soon as their skin hardens. It has, therefore, become possible to grow healthy seed crop in the plains without annual replacement of seed from the high hills.

### *C. Breaking of Dormancy*

Freshly harvested healthy seed potato from higher hills could not be used immediately for the main planting in the plains because of dormancy of seed and was planted late in spring when the crop is exposed to infection from virus diseases. The studies at the Institute have shown that dormancy can be broken with thiourea (a chemical) treatment.

### *D. Agronomic Studies*

Varieties gave differential response to potassic fertilizers. Exotic and improved varieties with rapid bulking habit and capacity to produce large-sized tubers showed higher response to potassium than indigenous varieties of longer duration and producing small-sized

tubers. Optimum date of planting was the one which gave the maximum response to nitrogen. Response to nitrogen was the highest with the moist or the wet region.

Storage studies showed that mainly small-sized tubers from crops lifted early before soil temperature rose in spring and tubers of varieties of long dormancy had better keeping quality. The effectiveness of the sprout inhibitor O-isopropyl-N-phenyle carbamate depended on storage temperature, being effective at 15° to 18°C but not at higher temperatures in the country stores.

### *E. Diseases and Pests*

The late blight is a serious disease of potato in the hills and at times in the plains. To combat this disease the blight-resistant varieties were bred at Institute. The selection of a variety depends to a great extent upon the presence of the races of the pathogen in different regions. The studies were, therefore, conducted to ascertain the racial picture of the pathogen in the potato-growing regions of the country. Race '0' was dominant in most of the potato-growing regions, Race '1' in the Nilgiris and Race '4' in the eastern hills of West Bengal and Assam, and on a restricted scale in the Simla Hills.

The fungicidal sprays offer a good protection to the crop against the outbreak of late blight. Dithane Z-78 and Dithane M-45 were effective in the plains and other warmer regions. The bordeaux mixture was more suitable for the Simla Hills. Besides these, a few other copper fungicides and tin compounds were also quite effective in controlling this malady.

The leaf-roll virus can be inactivated when potato is stored at high temperatures in ordinary stores in the plains. The studies also indicated

the possibility of heat-treatment of these seed tubers to eliminate this virus.

The root-knot nematode, poses a serious problem to the potato in the plateau areas and mid-hills. A new technique through the use of rooted leaves was developed to screen varieties resistant to nematodes. 'HC 294', 'HC 115', *Solanum vernii* and *S. spaggenii* showed resistance to root-knot nematode.

The charcoal rot, caused by *Macrophomina phaseoli*, is a major disease responsible for the



FIG. 3. A process of hybridization for the production of improved variety

rotting of tubers at lifting, during post-harvest handling and storage in the plains. Early lifting of the crop before the soil temperature goes up prevents infection with the rot-inciting organism and improved the storage behaviour of the produce.

#### INVESTIGATIONS IN PROGRESS

Further work on breeding of new varieties is directed towards convergent breeding to combine the desirable economic characters with resistance to viruses and other major diseases and pests. The recently developed technique of poly-haploids has added a new dimension to breeding varieties with desirable attributes, as with this technique a much smaller population of diploids is needed to bring about the recombinations. Besides, the technique has opened up great possibilities for transferring genes from a larger number of wild tuber-bearing species, majority of which possess resistant genes.

Suitability of a variety for a particular region depends upon its reaction to day-length and ability to utilize the light energy. In view of this, the varieties are now being screened for their photoperiodic response and photosynthetic efficiency to assess them for their regional and seasonal adaptability.

The studies on evolution of varieties suitable for processing and industrial uses, use of growth regulators, and keeping quality and storage of potato in cold stores and at ordinary temperature have also been undertaken. Work is proposed to be intensified on brown rot, newly recorded viruses and nematodes. □

# The System of Education in the USSR

O.L. OREKHOV

*Unesco Consultant, NCERT, New Delhi*

B.D. ATREYA

*Reader, DESM, NCERT, New Delhi*

THIS article describes an important aspect of the changes being made in the USSR with the immediate aim of expanding and raising the standard of general education. It is planned to bring the content of education in line with the requirements of scientific, technical and cultural progress and to make the complete secondary education compulsory for the entire younger generation.

The basic principles<sup>1</sup> on which the whole of public education in the USSR—from the kindergartens to the universities—is organized are as follows :

- equal educational opportunities for all citizens irrespective of race, nationality, sex, attitude to religion, property status and social position;
- compulsory education for all children and adolescents;
- the state and public character of all educational establishments;

- free choice of language for tuition; the right to receive instruction in one's native tongue or in the language of any other nationality inhabiting the USSR;
- free tuition at all stages of education, including higher education;
- state maintenance of certain categories of pupils; monthly grants and other benefits for students and pupils;
- a unified system of public education and continuity at different stages of education
- factors which make possible the transition from lower to higher levels of education;
- the combining of tuition with the communist upbringing with the joint efforts of the school, family and the public in educating children and adolescents;
- tying the tuition and upbringing of the rising generation with life and the practice of building communism;
- a scientific approach to education and continuous improvement of the educational process on the basis of the latest developments in science, technology and culture;
- humanism and the highest morality in education and upbringing;
- co-education;
- the secular character of education ruling out religious influences.

The present education system in the USSR is illustrated by a chart in Appendix I.

The preschool establishments, the nurseries

---

<sup>1</sup>Laid down in the "Fundamentals of the Legislation of the USSR and Union Republics concerning education" endorsed by the Supreme Soviet of USSR in July 1973.

and kindergartens, which the children attend from the age of 2-3 months to 7 years, are the first link in the chain.

In order to facilitate a smooth transition from the nursery school to the kindergarten, combined experimental nursery-school-kindergartens have been created. Here, if the parents so wish, their child is enrolled from 2 months to 7 years of age.

The children attend secondary schools from 7 to 17-18 years of age. The secondary school is divided into three stages: elementary school (1-3 grades), incomplete secondary school (4-8 grades) and complete secondary school (9-10 grades).

Where the subjects are taught in the native language, the council of ministers of the USSR may permit the establishment of an 11-year course of study. Until 1958, a seven-year education was compulsory; today this has been increased by one more year. Now we are completing the change-over to a compulsory 10-year secondary education (1975).

Apart from the ordinary general secondary schools, there are special secondary schools for music, art and foreign language, and schools for the gifted children. Special classes for mathematics, physics, chemistry and biology, are taken in some secondary schools. These schools are for those students who show a special interest or talent in these subjects. In all these schools the study of all regular subjects is unchanged, making it possible for a student to take a transfer back from one of these special schools to an ordinary school.

At present, the Soviet school system is changing over to a new, unified curriculum and programme schedule for the pupils in town and country (see Appendix 2).

The study of history, the social sciences and literature underwent a radical change. The

number of hours devoted to the natural science and mathematics has been increased, and polytechnic, vocational, and physical training were introduced.

One of the most serious shortcomings of the former programme schedules, was that it stressed on descriptive material in all grades upto the 8th, without sufficient theoretical generalization.

The new programme schedules take into consideration the different needs of each age-group and its ability to comprehend the theoretical material. Much factual knowledge and reference material that were earlier memorized have been removed from the programme.

## SCHOOL CURRICULUM

Preschool education is a part of a single system of education. The educational system in the kindergartens is not a rigid system. It is being constantly revised and improved upon in accordance with the latest scientific findings and the experience of the best establishments.

There are educational games which serve to develop correct speech patterns, to teach the children to draw, model with clay, music and singing lessons and rhythmic. The senior group is prepared for school. Here the children are taught to read and to do simple sums. These preschool subjects are conducted everyday during the period of 40-50 minutes.

Attending kindergarten has a great effect on a child's expanding knowledge: it develops good character traits, teaches a child to think, and to be disciplined and organized.

The children learn to speak well at an early age and they take interest in various art forms.

*The Elementary School* provides the basis for all further education. The elementary school system is changing over from a four-year period of study to a three-year period of study. The tasks of the elementary school are to teach the child to read, write and do sums, to provide an introduction to nature study and the social sciences, as well as to aesthetic, vocational and physical training, to develop the child's powers of reasoning and self-sufficiency. The course of language study includes grammar, reading, spelling, speed development, penmanship and the fundamentals of composition. Reading classes teach the child to read aloud, both expressively and quickly, and instil a love for books. The grammar lessons provide the fundamentals of grammar. Much emphasis is placed on the ability to express one's thoughts logically.

Mathematics provides an introduction to numbers and the four rules of arithmetic (from ten to numbers expressed by several figures), measures of time, length, weights, square measurements and simple fractions. Much emphasis is placed on doing problems and sums orally. There are elements of plane geometry and an introduction to algebra (symbols, composing formulae and using formulae in doing problems).

Elementary nature study provides an introduction to plant and animal life, as well as a study of the earth, the seas and the air. The children learn the geography of their native land, the fundamentals of anatomy and hygiene. Excursions and their own personal observations of nature make up a regular part of the course. The preservation of wildlife is taught and the children take part in planting trees and flowers.

The shop lessons teach the children arts and crafts: they also learn to make scale models and

learn the fundamental uses of electricity. These are outdoor classes on the school garden plot where they lay out vegetable beds, prepare them for sowing and conduct simple experiments in botany. The children in rural areas spend more time working on the garden plots than the city children.

Art classes include drawing from life and applied art. The aim is to teach the children to draw and to develop their taste and interest in art. There are also talks on great artists and art treasures. The art classes are tied in with the classes in reading and workshop.

Music and singing classes aim at developing the child's ear for music and teaching him to sing and appreciate music. Physical training is one of the most important factors in a child's all-round development.

The significance of this reform is that the pupils can be brought to a more advanced stage of development in a shorter period of time, which provides favourable conditions for their subsequent education. Moreover, it gives the secondary school an extra year, thanks to the fact that children now begin to receive systematic instruction in their mother tongue, mathematics and other subjects a year earlier than they used to.

*The Secondary School.* The greatest changes are made in the syllabuses for subjects in the secondary school. In Soviet secondary schools, physics, chemistry and biology are studied as separate, independent subjects from the outset. The new physics syllabus includes contemporary theories on physics in its presentation of the subject-matter.

In the sixth and seventh classes there is an initial physics course serving as an introduction to the systematic study of physics in the senior classes. This course differs from its predecessor in that it makes fuller use (qualitatively speak-



ing) of atomic, molecular and electronic conceptions for the explanation of phenomena—naturally within the range accessible to pupils in that age-group.

The new syllabus for senior classes covers mechanics, molecular physics, electricity, optics and nuclear physics. The material is grouped around general physical theories, principles and ideas; and instead of being contrasted with one another, traditional and modern physics are considered as an organic whole. The principal change made to achieve this is in the treatment of traditional material which has been brought into line with current physical thinking. For instance, in mechanics considerable use is made of ideas concerning the reading system, the relativity of motion and the vectoral character of a number of physical parameters (displacement, velocity, acceleration, force, impulse). The intention is to indicate the limits of applicability of the conceptions, laws and theories of traditional physics (constant mass, the law of additional velocities in traditional mechanics, and so on) and to reveal how they relate to or class with new facts and the solutions provided by the modern science.

The syllabus provides for a more detailed study of the atomic and molecular structure of matter, molecular-kinetic and electronic theory, and the theory of the electro-magnetic field. Greater emphasis is placed on the physics of the atomic nucleus and the elementary particles, in accordance with the modern classification of scientific facts. The explanation of nuclear processes is based on the laws of conservation: while the treatment of nuclear reactions and of the release of nuclear energy introduces the notion of the energy of the nucleus bond in the atomic nucleus. Various experimental methods are given for the study and determination of the type of charged particles. The course also

includes a review of the elementary particles that the pupils have encountered in their studies.

The physics syllabus now includes a course on 'elements of the theory of relativity'. This comprises the fundamentals of the special theory of relativity and experimental verification of the implications of this theory (nuclear processes, motion of charged high-energy particles in modern accelerators, relativity as manifested in the cosmos), the kinematics and dynamics of the special theory of relativity.

The polytechnical content of the physics syllabus is somewhat broadened and includes materials from the principal areas of the new technology (electronics, rocket technology, nuclear technology, semi-conductors, elements of automation, communications media, control and measurement techniques, etc.)

As before, the chemistry syllabus includes the study of the fundamentals of inorganic and organic chemistry. With greater emphasis on theoretical questions it is, however, more like a general chemistry course now.

The pupil will be introduced to the periodic law and the periodic system at an earlier stage. The study of the structure of matter and chemical bonding is brought more closely into line with the modern thinking. The general principles governing chemical reactions, rate of reaction, chemical equilibrium, catalysis are studied more thoroughly.

In the organic chemistry course, the treatment of the theory of chemical structure now includes a systematic exposition of the electron theory of chemical bonding and an introduction to modern theories on the spatial structure of molecules.

The polytechnical trend of the syllabus has been further developed in the new curriculum. More information is given on the metals of

importance to modern technology, and the basic principles underlying the main chemical production processes (production of fertilizers, ferrous and non-ferrous metallurgy, processing of combustible minerals, production of synthetic materials) are gone into in greater detail. The syllabus also includes a great deal of laboratory work.

The biology teaching in the Soviet schools takes the form of independent, successive courses in botany, zoology, human anatomy, physiology and hygiene and general biology. The new feature common to all courses is that they provide a clearer and more systematic account of the historical development of the organic world and considerably more information regarding the cell and its structure.

The botany course (fifth and sixth classes) includes more elements of cytology and histology, and physiological conceptions are dealt with more thoroughly.

In the new zoology course (seventh class) there is more emphasis on the taxonomy of animals and a number of new items are introduced that will enable the pupil to form an idea of the historical development of the animal world.

In the human anatomy, physiology and hygiene courses, in which the pupil learns about the vital processes and health maintenance of the human organism, more is now taught about cells (particularly cellular metabolism) and the elements of genetics are introduced. The course concludes with a new subject: "Development of the Human Organism", dealing with the role of chromosomes in the transmission of hereditary characteristics.

The general biology course is designed to explain to the pupil, in terms which he can understand, the nature of the fundamental

laws of life and of the individual and historical development of organisms.

The course begins with an account of the historical development of the organic world, including a detailed study of the teachings of Darwin.

The pupil then goes on to study the cell: the reproduction and individual development of the organism, the fundamentals of genetics and selection, and the organism and its environment. The recent data of organic, cellular, sub-cellular and molecular biology are included in this course.

The course ends on the theme of 'the biosphere and man' which deals with the general principles governing the life of the biosphere and revealing the role and place of man in nature.

The new mathematics syllabuses are also substantially different from the previous ones in both content and presentation. The systematic study of mathematics will start a year earlier than before, namely in the fourth class, and not with arithmetic as an independent subject but with a two-year introductory course called 'arithmetic and the rudiments of algebra'. This course will include algebra and geometrical material along side, and in close conjunction with, traditional arithmetic, the principal emphasis being placed on the study of equations and inequalities. A new feature of this course is the introduction and systematic use of the concept of sets.

The subsequent classes provide independent courses in algebra and geometry. In the algebra course there is a good deal more on functions. A very important innovation here is the fact that the pupil is introduced to exponential and logarithmic functions at an earlier stage than before.

Other fresh items in the syllabus are the conceptions of the derivative and the integral as well as an introduction to the simplest differential equations. Throughout the algebra course more emphasis is given to the systematic development of the pupil's calculating skill and to familiarizing him with the present day calculating techniques.

The geometry course is based on geometrical transformations. From the outset pupils will be given a fairly thorough grounding in three basic types of figure transposition: translation, rotation and axial symmetry.

The arts syllabuses comprising history, literature and language have also been improved. History as taught in the Soviet schools covers a wide span from the earliest times to the present day and is studied from the fifth to the tenth class. The main changes in the history syllabus are structural. Previously, it was built up on concentric principles. The pupils will study Soviet and foreign history side by side and in chronological order. A synchronistic approach has been adopted in the study of domestic and of recent and contemporary foreign history. There is a thorough treatment of the various periods of capitalism and, in particular, of the modern age. The syllabus now features special lessons devoted to bring out the salient points in the various sub-divisions of each course, and to summarizing and analysing the course as a whole. Provision is also made for a full coverage of questions relating to the history of culture at all stages of historical development.

In the Union Republic pupils are taught the history of their own Republic on the basis of the general course in the history of the USSR.

As before, the basis of the inclusion of the literature course is the study of the Russian classics. The outstanding works of the foreign

writers are also studied. The new syllabus includes three lists of works: (a) for compulsory study in class, (b) for compulsory independent reading, and (c) for independent reading. In addition a number of works, both the Soviet and the foreign, are introduced, e.g. the works of Dostoevsky, Bloch, Esenin, Fadeev, Marshak, Victor Hugo, Mark Twain, etc. The emphasis is laid on the theory of literature, which is more systematically dealt with in the new syllabus.

The Russian language syllabus has also been changed. A number of new topics like 'vocabulary', 'word composition and formation', and 'speech cultivation and stylistics' are introduced. The language syllabus provides for a considerable extension of the various types of practical work directed towards the development of the pupil's powers of speech and writing and the cultivation of a good style in his mother tongue.

The general purpose of all these changes is to promote the linguistic and general development of pupils and on this basis to improve their practical language training in line with the modern needs.

In order to take fuller advantage of the opportunities for developing the general and special aptitudes of pupils and preparing them for the different types of vocational activity, optional classes were introduced in the seventh to tenth classes. At these classes the pupils can obtain intensive instruction in some specific disciplines and acquire a theoretical and practical familiarity with the most important aspects of modern technology.

#### THE TEACHING STAFF

The school's teaching staff consists of the principal, his assistants, the teachers, the senior

young pioneer leader, the librarian and the school doctor. Together they form the pedagogical council. The school's administrators (the principal and his assistants) are appointed from amongst the teachers who have a higher education, the necessary teaching experience and are good organizers. The teaching staff is appointed by the district department of education and the principal is appointed by the department of education for the city.

The school principal has the powers of one-man management, but all the basic pedagogical problems are decided upon collectively through discussions at the pedagogical council. All decisions of the pedagogical council concerning a pupil's promotion, graduation or awards are final.

A well-planned distribution of tasks among the teachers is most important for the smooth functioning of any school. The teachers' tasks are as follows: being the home teacher for a given class, being in charge of the various laboratories, the school garden plot, leading a club, being responsible for a given sports match, or singing and dancing contests, etc.

An elementary school teacher's pay is based on 24 hours of teaching a week (I-III grades), while the salary of a teacher of IV-X grades is based on 18 hours of teaching a week. A teacher's salary also depends upon his educational background and the years he has put in teaching.

### THE SCHOOL BUDGET

The state allocates funds for the upkeep of the schools. Each school has a budget for the given fiscal year (from 1 January to 31 December), approved by the district department of education. The budget includes

salaries for the teaching staff and service personnel; funds for supplies, maintenance and business trips, school expenses including the purchase of new books for the library; the purchase of equipment and audio-visual aids; school meals; extra-curricular activities, and all renovations and repairs of the school building.

### REPORTS AND ACCOUNTS

The school's registry books are documents which serve as a source of information for government statistical progress reports. There is a single form of statistical reports for all schools. The first progress report is presented on 5 September, immediately after the beginning of the new school year. The second report is drawn upon on the basis of the results of the first-half year in every subject of the curriculum. The third report is devoted to the results of the school year. By studying the school progress reports and the results of the school inspector's check on the work, the various departments of education are able to obtain a clear picture of the situation for improvement.

### INNOVATION IN THE ORGANIZATION AND TEACHING METHODS

Much stress is placed on the development of each child's mastery of knowledge. This is achieved through the varied teaching methods, through well planned and well organized lessons and individual work of the pupils.

Various teaching methods were tested, both in theory and practice. As a result, the classroom lesson type changed to meet the principles of Soviet didactics was found to be most applicable. A permanent group of children

comprising a single class, takes all their lessons together either in their classroom or in the labs., in the school gymnasium or workshop and outdoors (classes in geography, biology, physical training, etc.). As a means of supplementary study, there are laboratory work and seminars for pupils of the higher grades. The homework which calls for independent effort, is a permanent feature, assigned every day. During classes the children are taught to work both independently and as a group.

The subject-room method of schooling has been introduced in the secondary schools as well, with special classroom for language study, literature, history, etc., besides the traditional physics, chemistry and biology labs. Each of these rooms has a great number of audio-visual aids and extensive reference material, making the lessons much more instructive than they might otherwise be.

In the higher grades there are lessons delivered as lectures, there is independent laboratory work and seminars at which a pupil makes a report and the class then discusses it.

The didactic advisability of methods of analysis and synthesis, induction and deduction depends on the given age-group and subject.

Visual aids, from textbook illustrations and experiments performed in class to educational films and TV, are widely used. The Central TV Network of the USSR and the TV networks of the Union Republics carry a number of educational programmes. All these didactic and methodological measures are aimed at providing an all-round education.

Computerised teaching is being widely introduced on an experimental basis. During the past years, special attention has been paid to using electronic teaching devices, and many new models have been designed. However, even with the most varied uses in education of the principles of computerised and electronic teaching, the teacher plays a leading and decisive role in organizing the educational process.

Polytechnical education makes clear to every pupil how the achievements of science and technology are applied in industry and agriculture, in everyday life, teaching him how to teach and use the knowledge he has gained at the school.

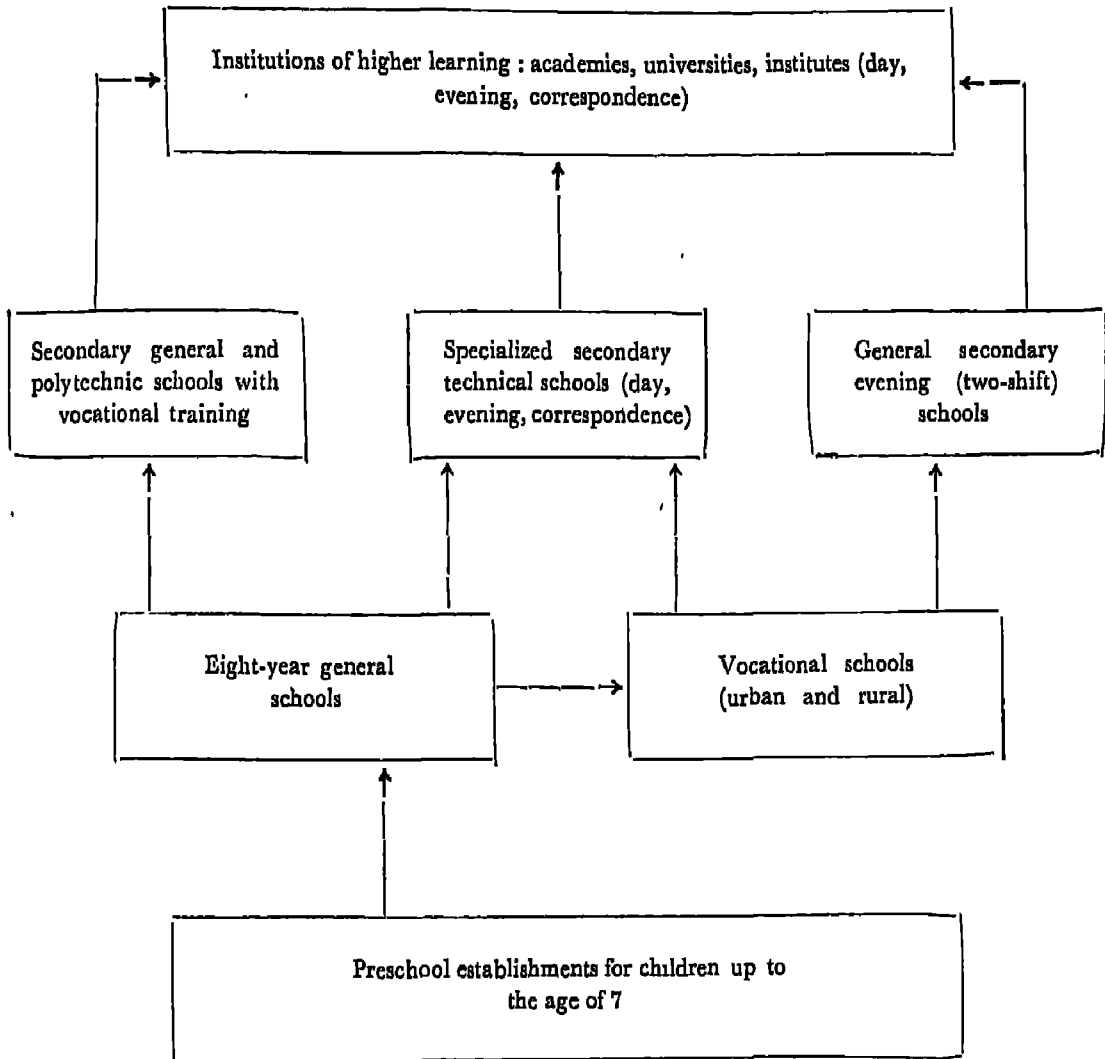
The pupils go on excursions for nature study. They visit factories, farms, museums and exhibitions.

The Soviet society as a whole takes an active part in directing the work of the schools. The parents' committees are active in various capacities in every school and the children's establishment with the principle of one-man management are observed throughout. The family and the school comprise an integral whole within the educational system. The family helps the school, while the school helps the family.

Extra-curricular activities are held during the second half of the day. The teachers try to help the children discover those activities which will be of interest to them. The work of the various clubs is guided by the teachers, parents or specialists from the organization that sponsors the school.

## APPENDIX 1

## THE SOVIET EDUCATIONAL SYSTEM



APPENDIX 2  
STANDARD SCHOOL CURRICULUM

Subject	Number of hours per form											Total hours per week	
	1	2	3	4	5	6	7	8	9	10	11	1908	1958
1. Russian language	12	10	10	6	6	3	3	2	2/0	—		53	57
2. Literature	—	—	—	2	2	2	2	3	4	3		18	10
3. Mathematics	6	6	6	6	6	6	6	6	5	5		58	59
4. History	—	—	—	2	2	2	2	3	4	3		18	20
5. Social science	—	—	—	—	—	—	—	—	—	2		2	2
6. Natural science	—	2	2	2	—	—	—	—	—	—		6	2
7. Geography	—	—	—	—	2	3	2	2	2	—		11	12
8. Biology	—	—	—	—	2	2	2	2	0/2	2		11	11
9. Physics	—	—	—	—	—	2	2	3	4	5		16	17
10. Astronomy	—	—	—	—	—	—	—	—	—	1		1	1
11. Draftsmanship	—	—	—	—	—	1	1	1	—	—		3	4
12. Foreign language	—	—	—	—	4	3	3	2	2	2		16	20
13. Chemistry	—	—	—	—	—	—	2	2	3	3		10	11
14. Pictorial art	1	1	1	1	1	1	—	—	—	—		6	7
15. Singing music	1	1	1	1	1	1	1	—	—	—		7	8
16. Physical culture	2	2	1	2	2	2	1	2	2	2		20	22
17. Manual work	2	2	2	2	2	2	2	2	2	2		20	22
Total compulsory lessons	24	24	24	24	30	30	30	30	30	30		276	330
Optional lessons	—	—	—	—	—	—	2	4	6	6		—	—
Grand total	24	24	24	24	30	30	32	34	36	36		—	—

## Science News

---

### MAN AND ENERGY

---

#### **Bio-gas may meet village energy needs**

ABOUT 50 per cent of rural India's domestic fuel requirements could be met by bio-gas (methane) produced by the fermentation of the dung of the country's 220 million cows and buffaloes. Besides, the left-over from the process—the nitrogen-rich waste that remains once the gas has been drawn off—could help save up to 30 per cent of the costly chemical fertilizer which is such a drag on India's currency reserves.

This was the view expressed by an Indian electrical engineer, Dr. Krishna Murthy, the Institute of Technology and Science, Indore, at an international forum in Paris on fundamental scientific and technological energy problems.

#### *Simple and cheap*

Bio-gas production is a simple and cheap method of solving energy problems in the 600,000

villages where over 70 per cent of India's population live. "Conventional electrification of these far-flung villages whose population ranges from 200 to about 5,000, would be extremely expensive," Dr. Murthy said in an interview. "But small, autonomous fermentation plants, based on a freely available raw material, cow-dung, can supply the gas needs for cooking and elementary lighting in rural communities."

Over 7,000 of these simple plants—consisting of a concrete pit where the manure ferments in a cast-iron holder and where the gas accumulates before being piped to homes—have already been installed in Indian villages and the Government plans to set up a further 20,000 within the next four years.

The plants—which come in three different sizes, for 5, 25 or 50 families—are provided by a government agency, the Village Industries' Commission, which also teaches the villagers the elementary know-how needed to operate them.

Whereas most of the industrial countries located in the temperate zone have to apply artificial heating to produce methane from organic matter and industrial and municipal waste. Besides, the temperature of the air in most parts of India, varying from 25° to 35°C, is sufficiently warm to ensure spontaneous fermentation.

Once the gas has been piped off, the remaining waste, or slurry, is an extremely efficient fertilizer, much richer in plant nutrients than manure in its natural state. Its nitrogen content is 2 per cent, compared to only 0.75 per cent in ordinary cow-dung.

Will the bio-gas scheme be run on a commercial basis? Dr. Murthy was asked. No. Centralized commercial exploitation would be



too expensive because it would mean installing gas meters and keeping an account of consumption.

The system is run on a cooperative basis with five or six families, or a whole village, coming together, pooling their organic manure resources and sharing the end-products: the bio-gas and the enriched fertilizer.

Government subsidies cover about 50 per cent of the plant's installation costs and members of the cooperative pay the rest.

#### *Education to overcome resistance*

There are scarcely any overheads, since the raw material—cow-dung—is free. What problems there are, Dr. Murthy said, are social rather than technical. "Whenever you have a cooperative venture of this kind," he said, "there are bound to be difficulties in getting people to work together. In this particular case there has been a certain amount of resistance to using gas produced from animal manure for cooking purposes. Education is the key, and I think that eventually we will get over the problem."

### **Indian scientists explore power source in the Rann of Kutch**

SCIENTISTS at Jadavpur University are exploring the possibilities of generating electricity by using sea-water evaporated by the sun.

The scientists are looking into this possibility for the 900 square kilometre (560 sq. miles) area of the Little Rann of Kutch. The rann—which means a swamp region—is a land of high temperature which makes it sandy and dry parts of the year while monsoons flood it with sea-water the rest of the time.

During the dry season, when there is little moisture in the air, a high evaporation rate causes the water in the rann to drop. The idea is that sea-water can be fed into the low-lying land, passing through a turbine that generates electricity. Having turned the turbine the sea-water would then be disposed of by evaporation.

According to the Jadavpur University scientists, Professor D. N. Bandyopadhyaya, a geologist, and K. Majumdar and B. Bose, both engineers, a sea-dam could be built near Kandla on the Gulf of Kutch which would give a waterfall of three metres (10 feet). This would enable a turbine generator to produce at least 25 megawatts of electricity round the year, the professors say.

The cost of the project could be recovered in 10 years, according to their estimates.

—Unesco Features

---

#### MAN AND MICROCOSM

---

### **U.S.A. bans 'dangerous' genetic research**

U.S. NATIONAL Institute of Health (NIH) has issued rules to guide a controversial type of genetic research, banning some experiments considered too dangerous to perform.

The rules for the recombinant DNA are designed to control what some see as the almost God-like potential of science to create *new forms of life*. Critics fear the research could create super disease organisms not found naturally and they may be immune to all medicinal and other defences against them. The supporters of such research, however, say that it has a vast

scientific potential. They look forward to turning bacteria into little generators of valuable proteins and hormones, such as insulin and blood-clotting factor.

The DNA—deoxyribonucleic acid—is the chemical that forms genes, the basic units of heredity. the recombinant DNA molecules result from recombining in a test tube the DNA from different species of life.

Genes for specific inherited traits, taken from one species, are combined with those of another, usually by removing a gene from a higher organism and putting it into bacteria. When the modified bacteria reproduces, the offspring contain characteristics of a new gene.

The rules prohibit combining genes from certain virulent disease organisms into others, transferring drug-resistant traits to microorganisms that could compromise the use of a drug to control disease. They also prohibit forming recombinants with genes that can synthesize potent poisons. The rules also prohibit large-scale experiments—those with more than 10 litres of culture—with recombinants known to make harmful products.

## Plant tissue culture for agriculture and afforestation

Dr. B. D. Tilak, Director of National Chemical Laboratory, said that several applications of plant tissue culture techniques had been used for the propagation of vegetable and ornamental plants.

At a conference on plant tissue culture and the practicability of its application to agriculture, Dr. Tilak said the propagation of hybrid cabbage and hybrid snapdragon had been

successfully achieved at the NCL, and commercial field trials of the new methods of cabbage cultivation were currently in progress at the laboratory and at Phaltan (in Maharashtra).

There is a great scope, through the development of plant tissue culture, for rapid propagation of plants without the use of seeds, elimination of viruses and other pathogens from plants and mutation for producing agriculturally superior breeds.

The propagation of forests and other trees by tissue culture technique, if successful, would be of great importance for horticulture and afforestation programmes.

---

## THE WORLD WE LIVE IN

---

### A new chart of the undersea world

PUBLICATION has begun of a new chart that shows for the first time the true face of the 70 per cent of the earth covered by salt water. Besides its scientific importance, the chart has a particular significance coming at a time when the world's nations are trying to put forward claims to the wealth of the sea-bed.

A few months ago the newly-printed first sheet of the 5th edition of the *General Bathymetric Chart of the Oceans*, usually known as GEBCO, was displayed in Geneva at the Third United Nations Conference on the Law of the Sea.

Covering the Northern Indian Ocean and the Mediterranean, it was brought out by the Canadian Hydrographic Service and is a model of international teamwork.

On the sheet are parts of four major

oceanic basins. The bottom features of the Northern Indian Ocean were taken from the recently published Geological-Geophysical Atlas of the International Indian Ocean Expedition, edited in Moscow which also supplied Soviet sheets for the Black and Caspian Seas. Contours of the Mediterranean came from the Institut Francais du Petrole (French Petroleum Institute) while the Lamont-Doherty Geological Observatory in the United States provided data for the Gulf of Guinea.

The new edition of GEBCO is the product of a joint guiding committee established by Unesco's Intergovernmental Oceanographic Commission in Paris and the International Hydrographic Organization in Monaco. And, for the first time, the scientific findings of the past two decades of ocean exploration are reflected by GEBCO.

The history of the General Bathymetric Chart of the Oceans is a century old. D.W. Newson of the Hydrographic Department in the United Kingdom, traces its origins back to the expedition in the 1870s of the *H.M.S. Challenger* which sailed 112,500 kilometres (70,000 miles) taking soundings with a hemp line 6,000 fathoms long and showing for the first time that the ocean bed was not a flat plain but as complex as the surface of the land.

In 1899 at the 8th International Geographical Congress in Berlin, a commission was set up to study producing a standard bathymetric chart of the ocean, that is, a map identifying the features of the bottom rather than just displaying soundings as hydrographic charts tended to do.

The commission's chairman was the pioneer oceanographer, Prince Albert I of Monaco, who offered to finance the first edition of GEBCO. The chart was divided into 24 sheets

and drawn on a scale, still used, of 1:10 million.

Eighteen thousand soundings were plotted on the first edition, a number that rose almost in geometric progression with the advent in the 1930s of the echo sounder to replace the lead line of the "Challenger" days. By the fourth edition, the U.S. Naval Oceanographic Office alone was supplying 900,000 soundings for GEBCO. Starting in 1932, production was taken over by the International Hydrographic Bureau in Monaco when the task became too great for the Scientific Cabinet established by Prince Albert.

Later, GEBCO ran into trouble. Hydrographers were regarded by marine geologists as a conservative lot more interested in the safety of navigation than in the dynamics of the sea floor. Though such an attitude was good for mariners, it was bad for science. The chart series did not sell and funds could not be found to finance the printing of the 4th edition.

"No one wanted them," said Dr. Anthony Laughton of the Institute of Oceanographic Sciences, Wormley, England, where the first sheet of the new chart was compiled. "They might just as well have been wallpaper."

Laughton is serving as co-ordinator for the next sheet, covering the North Atlantic, to be published in the 5th edition of GEBCO. There will be 18 sheets in all.

The government of Canada has agreed to print the first four sheets and to act as host to the GEBCO geoscience unit. And the United Nations Development Programme has been asked for \$130,000 a year over five years so that all 18 sheets can be printed in Canada.

The joint GEBCO guiding committee points out that a world series of bathymetric charts is needed to determine the boundaries of seabed

areas that will fall under national jurisdictions.

In this new form, GEBCO is also more likely to attract contributions by scientists and these will be gratefully accepted. "We already know a lot about the bottom of the ocean," Laughton remarked, "but it is very, very big."

## Catalogue of Balkan quakes

SOME 2,000 years of Balkan earthquakes are listed in a catalogue prepared under Unesco auspices in cooperation with specialists in Bulgaria, Greece, Romania, Turkey and Yugoslavia.

The *Survey of Seismicity of the Balkan Region*, the project, financed by the U.N. Development Programme, includes improving the area's seismic observatory network.

## How to predict an earthquake

A SUCCESSFUL attempt to predict a major earthquake and the large-scale evacuation of the endangered population that ensued have been described for the first time at an international scientific meeting.

At the Intergovernmental Conference on the Assessment and Mitigation of Earthquake Risk that drew 150 delegates from 45 countries to Unesco headquarters in Paris last February, shortly after the earthquake that struck Guatemala on 4 February, this year, leaving 22,000 dead.

An account of the prediction was given by the head of the Chinese delegation, Liu Ying-Yung, director of his country's State Seismological Bureau. He told of the methods used to

forecast the Haicheng earthquake that occurred in Liaoning province on 4 February 1975 with a magnitude of 7.3 on the Richter scale.

The region had been monitored for nearly ten years. Following the strong Hsingtai earthquake in Hopei province in 1966, scientists observed that epicentres of smaller shocks seemed to be migrating north-east towards Liaoning province.

So, Liaoning was placed under close surveillance in 1970. Geodetic levelling across a major fault showed that the ground was rising 20-time faster than normal. Changes in sea level and in the earth's magnetic field were also observed.

Other signals of a coming earthquake were found. In one area, wells suddenly became muddy and bubbling, while farmers reported unusual animal behaviour—rats and mice left their holes, so did the hibernating snakes.

At the beginning of February 1975, 22 wells became artesian, while the flow of water at a hot spring was cut off three times. At one seismological station, measurements showed that terrestrial electricity had suddenly decreased after a month-long rise. A series of small earthquakes was recorded in a previously quiet region and seismologists assumed they indicated a much larger shock on the way.

At this point, the authorities went into action: "Without delay, the masses of people were notified to build temporary living huts, to move patients from hospitals, to concentrate transportation facilities, to organize medical teams, to move the old and weak to safe places..."

At 7.36 on the evening of 4 February, the earthquake struck but, because of these precautions, "losses of human and animal life were greatly reduced", even though more than 90 per cent of the homes collapsed in the hardest-hit area.

The Chinese effort in prediction goes back to the Hsingtai earthquake of 1966. It was then that the late Premier Chou En-lai put a priority on seismology with the result that the country now has 10,000 professional and 100,000 amateur seismologists operating a network of 17 stations and nearly 300 regional stations. Responding to questions from the floor, the Chinese delegation told the Unesco conference that more than ten earthquakes with a Richter magnitude greater than five have been accurately predicted.

Other countries, notably Japan, the U.S.A. and the U.S.S.R. have also been conducting research in earthquake prediction and the conference heard of some of their results.

Dr. Robert Hamilton of the U.S. Geological Survey related how the San Andreas Fault in California has been instrumented with fifty tiltmeters, while the installed laser-ranging equipment is sensitive enough to detect a crustal deformation of the order of one centimetre over ten kilometres.

It is the tiltmeters that have yielded the most encouraging results. Since November 1974, said Hamilton, three earthquakes of magnitude 4 or greater have all been preceded by a tilt anomaly. The instruments start to deflect about a month before the earthquake and keep on deflecting until it occurs.

One should note, however, that stakes are not the same everywhere. In the United States, only 1,600 lives have been lost in earthquakes during the entire history of the country and the typical American wooden homes can be expected to ride out shocks. This is not the case of China where the worst earthquake of all time occurred at Huahsien, in Shensi province in

1556, leaving 820,000 dead. Here, high seismicity is combined with a dense population living in the traditional heavy-roofed houses.

The conference also took up the social implications of earthquake predictions. In certain cases, experts fear that the economic effects of a forecast could be almost as severe as those of the actual shock, since industry would move out and construction come to a halt. Further research by social scientists is needed in this area because experience also indicates that people learn to live all too well with earthquake risk.

Engineers can now build earthquake-resistant structures, but something like 2,000 million people live in buildings without such safeguards. It is the poor in the developing countries who face the worst danger, particularly when heavy mud or clay roofs are used as protection against heat and cold. If these are not houses braced, as is often the case when timber is scarce, they collapse and crush their inhabitants.

This led the conference to recommend that Unesco support international research to reduce the risk of earthquake damage to such houses and develop inexpensive ways of strengthening them.

To continue its work on a permanent basis, the conference asked that a Joint Committee on the Assessment and Mitigation of Earthquake Risk be set up by Unesco in consultation with the United Nations Disaster Relief Office. This proposal will go before the nineteenth session of the General Conference of Unesco when it meets this year in October and November in Nairobi.

—Unesco Features

## MARINE LIFE

**The food fish take**

ON a world map, the north-west coasts of South America and Africa appear almost similar, one jutting out in the Pacific Ocean and the other into the Atlantic. Both are upwelling regions where the prevailing surface current turns offshore, and cold water rich in nutrients comes up from the bottom to replace it.

Yet the Peruvian anchovy fishery off South America is the world's biggest and there the annual catch is ten times higher than in the waters of north-west Africa.

Wondering why this was so, the oceanographers in the Coastal Upwelling Ecosystems Analysis programme, now being conducted in the United States, decided to make a comparative study. Its results have been reported in a recent article by Susan A. Huntsman and Richard T. Barber :

The level of the major nutrients—nitrates, phosphates and silicates—that fertilize the growth of phytoplankton was three to four times higher off the coast of Peru than in the waters of north-west America.

Not only that, but the winds are twice as strong on the shelf off north-west Africa. They keep the sunny upper layer of the sea in a constantly mixed state, driving the phytoplankton down the shadier depths where they grow only half as fast.

Besides, the food chain is much shorter off Peru where the anchovy feed directly on the phytoplankton. Off the north-west Africa, not only is the plant production lower but the food web is relatively complex with a number of

intermediate steps before it reaches the fish of commercial value.

—Unesco Features

## WILD LIFE

**Bengal tigers to drink fresh water**

INDIAN authorities are testing a theory that Bengal tigers might give up eating humans if they drank fresh instead of salt water.

The most majestic of India's tiger population, the Bengal tigers are estimated to be down to about 150 specimens. Nevertheless, they manage to kill about 40 people a year in their habitat, the Sunderbans, a 1,300 square kilometer (500 sq. mile,) forest of mangrove swamps and stunted trees inundated by salt water from the neighbouring Bay of Bengal.

In an attempt to halt their man-eating and thus save the tigers from being killed in turn, forestry workers are to put up giant troughs which will be filled with fresh water. Watch towers will be built to observe the tigers' reactions to the new drinking water supply.

India's total tiger population was estimated to be about 1,800 in 1974 as compared to 4,000 in 1947.

—Unesco Features

**More tigers in Assam sanctuary**

THE latest census under "project tiger" in Assam's Manas wild life sanctuary has established that the tiger population is definitely on the increase. The figures for the last census are being compiled, but the forest sources are confident that the total will be close to 50 or more.

A pointer is the confirmed increased in the deer population, and deer, as is known, is the basic feedstock for the tiger. 'Project Tiger' is

being extended to the Bhutan portion of the Manas sanctuary; a joint management plan is being prepared. In all probability the joint management will vest in the "Field Director of the Tiger project."

Apart from poaching, some good tiger habitat was dereserved for agriculture. And there has been heavy encroachment on the forest limits in various places. 'Project Tiger' is a unique international effort to conserve wild life in its natural surroundings, but some of the impediments will require prompt action by the higher authorities.

### **Listing the vanishing species**

THERE are only 40 pairs of whistling teal left in the Brahmaputra valley. The famous dancing deer, the Manipur thamin, are on the endangered list, with only 14 pairs surviving in their natural habitat. The white-winged wood duck is almost extinct in Assam and so is the gharial in the Mahanadi basin.

The white-winged wood duck perhaps heads the list of endangered birds in the north-east. Attempts at conservation are largely marginal since the bird is nocturnal in its feeding habit and inhabits virtually inaccessible virgin forest laced with jheels and sluggish creeks. A valuable contribution, however, is the success at Slimbridge in Britain where 19 birds had been bred in captivity till two years ago from a nucleus of six birds caught in upper Assam and sent there. These birds were gifted to the Slimbridge Wild Fowl Trust by a planter named MacKenzie. Slimbridge, it may be recalled has had some success with another endangered species, the Hawaiian goose.

The Gauhati Zoo has also been successful in breeding them in captivity. It acquired four

birds in 1970, paired a male and female, and three ducklings were hatched in June, 1973. The zoo now has seven birds.

In 1962 the World Wild Life Board listed the white-winged wood duck as threatened with extinction and the World Wild Life Fund got interested in saving the bird.

The species was common in eastern Assam in the late 19th century and the early 20th century. In 1881, Col. Graham had numerous sightings of the bird in Lakhimour district in the foot-hills of Arunachal. Men like Bakar (in 1908 and 1928) and others substantiated the evidence and recorded many birds in the Lakhimpur and Sadiya areas. During the past 40 years the bird seemed to have vanished—barely six were recorded by Hutchinson, All and Repley, and E.P. Gee. Recent sightings as reported by Gee include a pair from Tezy and Brahmakund in Lohit division of Arunachal, three from the Doom Dooma area in 1958 and two pairs from the Ranga reserve forest the same year.

In 1961, a Zoological Survey of India team led by Dr. A.K. Mukherjee tried to assess the status of the bird. It found a single specimen in the upper Dihing forest and a pair in the Dibru forest reserve. Apart from breeding the bird in captivity and the periodic efforts to assess the status of the bird, little is known about the range of its distribution at present.

MacKenzie, before he left India, had suggested that the Dharmara and Doom Dooma reserve forests should be considered as possible sanctuary for the bird. The general area of upper Assam has certainly traces of the bird. A very recent survey showed up a pair in the Kumsong reserve of Dibrugarh district. Experts feel that the present area of distribution of the duck is barely 5 per cent of its distributional area at the turn of the century.

## Birds to watch for

THE Bombay Natural History Society has appealed to people to be on the lookout for three rare birds, Jerdon's or doublebanded courser, pinkheaded duck (*Rhodonessa caryophyllacea*), and the forest spotted owlet (*Athene blewitti*).

So that the common is not mistaken for the rare, the Society has issued pamphlets to help people make the distinction.

Jerdon's courser is so rare that it has not been "reliably seen" since 1900. It was then known only in the Godavary and Pennar Valley in Andhra Pradesh. Its double breast band distinguishes it from the commoner Indian courser.

The last definite record of the pinkheaded duck is a live specimen brought by the late Mr. C.M. Inglis in Darbhanga district, Bihar, in 1935. There have been reports of sighting it since, but these have been found unreliable. The bird seen has often turned out to be the red-crested pochard, which has a bright, chestnut head and goes by the name of "lal sir" (red head) which is said to have been used also for the pinkheaded duck.

The duck was restricted mainly to north-east India and Burma. The pale rosy tint on the under surface of its wings was said to be conspicuous in flight, making the species distinguishable even at a distance.

The forest spotted owlet is often mistaken for the common spotted owlet (*Anthene brama*). The first has no spots on the crown, has a dark tail and is confined to thick forests. The other, with spots on the crown, inhabits villages and towns.

Sightings should be reported to the Society at Hornball House, Shahid Bhagat Singh Road, Bombay.

---

## LONG LONG AGO

---

### A stone age man worked here

How old is Bangalore? To the historian it is nearly 450 years old. He tells us that this city owes its existence to a chieftain, Magadi Kampe Gowda, who founded it in 1537 with a mud fort and called the township around it 'Bengaluru'. He visualized a great future for his dream city, the limits of which he marked by four towers in the cardinal directions. The city, however, has extended far beyond these towers, which are today merely a reminder of the founder, who was also responsible for the numerous temples which dot it.

The archaeologist, however, looks farther back. Sites excavated near the Hindustan Aeronautics complex, towards the east of the city, show the contacts this place had nearly 2,000 years ago, when it was a trading centre with the Roman world. Recently the archaeologist has discovered a prehistoric site which will push back the history of the site by another 3,000 years.

In the course of exploration of a suburb of Bangalore, an important prehistoric site, was discovered by Mr. S.R. Rao, Superintending Archaeologist, Mid-Southern Circle, at the foot of a hillock known as Ragigudda, in Jayanagar Extension. Several tools of the late stone age were collected both from the surface and from the sections of pits dug for laying a road.

Considering the high proportion of finished tools and the large quantity of flakes found within an area of about 100 sq. miles, Ragigudda can be said to be a factory site of the late stone age man, says Mr. Rao. The granite boulders provided shelter to the tool maker, while raw



materials such as quartz and rock crystal were available locally.

The main tool types found are triangle, lunate, blade burin and point. Topographically, the site may be linked with the recently discovered microlithic sites at Hulimavu on the road to Bannerghatta about 20 km from the city, which is being developed as a National Park. There a very large rock shelter (60 × 20m) containing deposits of habitation by the late stone age man was discovered by Mr. Rao last August.

The tools from Ragigudda and Hulimavu represent in the archaeologist's view, a true microlithic industry, since the majority of the tools are less than 2 cm in length.

Iron age pottery have also been found at Ragigudda, the main ceramic ware being black and red, showing a crackled surface. The iron age people, Mr. Rao feels, must have occupied the site where the late stone age people were living earlier.

Whether the late stone age industry survived right into the iron age, as on the east coast, can be known only after further excavation. The Archaeological Department has plans to excavate the area Mr. Rao feels that there must be a series of microlithic and megalithic sites in the area extending towards Bannerghatta.

With the discovery of the rock shelter at Hulimavu and the site at Ragigudda, a continuous sequence of the prehistoric cultures of the Bangalore area can be said to have been traced.

After further excavation of the Ragigudda area; the archaeologist will be in a position to say how old the history of Bangalore is. "We have taken the history of the city site back to at least 5,000 years" says Mr. Rao.

## Oldest human remains found

ANTHROPOLOGISTS have discovered the skeleton of a young man believed to date back 400,000 years, the oldest human remains ever found in Europe.

The skeleton was found preserved in a stalagmite during an exploration of the Petralona cave in the Chalkidiki peninsula in southern Greece. Dr. Aris Poulanos, President of the Greek Anthropological Society, said:

"We discovered the cooked meat of rhinoceros, bear and deer which proves men who lived in the cave made logical use of fire—that is to say, they cooked food before they ate it."

---

## FROM THE FIELD UNITS

---

### MADHYA PRADESH

## Development in mathematics education

THE Textbook Corporation, Madhya Pradesh, Bhopal, has completed the preparation of Teacher's Guide in Mathematics in two volumes, for Classes I to V and VI to VII.

The Directorate of Public Instruction, Madhya Pradesh, has prepared a programme of orientation of 1200 school teachers of the State for teaching new mathematics during summer vacation.

\* \* \*

The Standing Committee of Textbook Corporation has approved 117 books written in minority languages (i.e. Marathi, Gujarati, Oryia, Sindhi and English) for Classes I to

VIII in Science, Mathematics and Geography. Bal Bharti, a textbook in Hindi for primary classes has also been translated into minority languages. The Textbook Corporation has assured the Government to make all these books available to the students and schools in July, 1976.

### **State plans for pre-science talent summer schools**

On the request of the Directorate of Public Instruction, Madhya Pradesh, Bhopal, the Regional College of Education, Bhopal, in association with the Office of the Field Adviser, has conducted a six-day orientation course for key resource persons at State Institute of Science Education, Jabalpur. These persons will conduct Pre-Science Talent Summer Schools at ten divisional headquarters during summer vacation. The instructional material prepared by the Board of Secondary Education were distributed to the participants for their future guidance. On the last day all participants were honoured by the Mayor, Municipal Corporation, Jabalpur.

\* \* \*

The Office of the Field Adviser conducted a two-day Orientation Course for 28 local Science lecturers for Pre-Science Talent School at State Institute of Education, Bhopal.

### **CET takes interest in SITE programme in the state**

THE CET, NCERT, has organized a ten-day workshop for try-out and validation of non-det-

ailed activities in connection with SITE programme of State at State Institute of Science Education, Jabalpur. Ten primary teachers from nearby SITE districts and not participated in 12 days in-service programme attended the workshop. All the participant teachers were taking great interest in the activities of the workshop which gives us the indication that the activities planned for the purpose are meaningful to them. This shows the success of the SITE programme in Madhya Pradesh.

### **Encouragement to teacher-writers**

IN order to encourage the teachers of various levels for their original, creative and productive writing, the Board of Secondary Education, has launched a scheme in which all the teacher-writers of the State have been requested to write articles about the experiences of their teaching subjects and related matters. More than 300 articles have been received by the Board which are being scrutinized by the team of experts. About 20-30 best articles will be printed in the form of magazine by the Board for their wider circulation in the State and encouragement to others. The special function organized by the Board.

GOA

### **Measures to help weaker sections of society**

A SUM of Rs. 4.5 lakhs had been allotted to open high schools in rural areas and set up book banks for poor students. It was also proposed to expand the present scheme of scholarships and stipends to cover girls belonging to economically weaker sections.

## MAHARASHTRA

**The popularity of coaching classes**

A SAMPLE survey has revealed that nearly 42 per cent of Pre-degree students (now Std. XII) joined coaching classes during the year 1975-76. About 54 per cent students from the commerce faculty, joined these classes. They were followed

by 43 per cent science and 11 per cent arts students. Among the science students, 90 per cent joined for coaching in mathematics and 25 per cent for physics. Among the commerce students, business mathematics claimed 50 per cent. In the arts faculty students appear to join mainly for coaching in English. The tuition fees paid by a student for "coaching" ranged between Rs. 30 and Rs. 60 per year. ☐

## Book Review

### *Facts and Fantasy in Physics*

M.K. Sarma, Published by Mrs. R. Sarma,  
New Road, Jorhat-1 (Assam), Price : Rs. 2.25

WITH a view to motivating the students of our schools and colleges, Mr. Mukul Kumar Sarma's book *Facts and Fantasy in Physics* is indeed welcome. There can hardly be two opinions regarding the fact that despite the best efforts of the teachers there is lot to be done towards the improvement of the quality of education at all levels. For one thing, there should be more emphasis on understanding and applications rather than rote memory of some factual knowledge; for the other, there should be scope for 'open enquiry' 'in all phases of teaching-learning situations.

As a sample, the author picks out at random some of the well known themes such as the velocity of light, anti-matter, molecular motion, rectilinear propagation of light, the size of the earth, propagation of sound, the atmosphere, the moon and Newton's third law of motion. Each theme is dealt in two parts: the first part deals with some relevant facts related to the topic while the second part diagnoses some of

the consequences that would result if the situation were just the reverse. The author calls the second part *fantasy*.

The 'facts' part of the book has been very succinctly put; the 'fantasy' part is mostly speculative and rests to a large extent on the philosophical principle of '*reductio ad absurdum*'. One wonders whether such an approach is very conducive at the formative stages in schools? What is more, science strives to understand experience generally by the *construction* of theories, laws and principles. Indeed, according to experts: 'The first requirement for creativity is that one deliberately opens one's self to new experience...What is required is that one learns to take an open unstructured look at the data available'.

There is a danger therefore that the creative urges of the children may be stifled by the negative structure imposed in the process of 'thinking in absolutely different and uncommon lines' as claimed by the author. Knowing as we do that scientists are puzzle-solving kind of people, I would be inclined to think that students should be given ample opportunity of being open to experience for

'Happy the man who studying nature's laws  
Through known effects can trace the secret cause'

Nonetheless, it is a thin volume of about fifty pages and is certainly unique in its logical presentation of the fantasies. Surely, some students will find the book interesting and stimulating.

S. N. DUTTA<sup>15</sup>  
Department of Education in  
Science and Mathematics, NCERT

# Scientific Terms

## Used in This Issue

**Aphid period :** Period vulnerable to infection of *Aphis*-a genus of hemipteran insects which suck plant sap. Some of these insects carry virus diseases.

**Fungicidal :** Pertaining to agents which kill and destroy fungal (various kinds of moulds and mushrooms) population.

**Mutation :** Sudden change in a gene or a chromosome, which in turn is related to the changes in chromosomal DNA, resulting in the change in heredity

**Nematode :** A member of the animal phylum Nematode—usually round-worms, thread-worms and eelworm. A large number of them live as animal and plant parasites; some are free living, found in water and soil.

**Pathogen :** Disease producing agents—usually bacteria, fungi, protozoans, viruses and other parasites.

**Photoperiodic :** Pertaining to the response of plants to relative length of day and night. Flower initiation is the best known example of a large number of such responses. The photoperiodic response have hormonal regulation.

**Photosynthesis :** The synthesis of carbohydrates from carbon dioxide and water using solar energy absorbed by the green pigment of the plant. This life process of the green plants is the source of most of the atmospheric oxygen and the primary source of food for the living world.

**Replication :** Production of exact replica or copies of large organic molecules in living organisms which occur mainly during their growth and reproduction.

**R.N.A. :** Ribonucleic acid, a complex organic molecule consisting of large number of nucleotides in a chain. Each nucleotide contains purine and pyrimidine bases (Adenine, Guanine, Cytosine and uracil) and ribose sugar. It acts as an active agent for translation of the DNA information. In some viruses it is the inherited material of genetic information.

**Transcription :** Synthesis of R.N.A in the exact sequence of nucleotides by matching with D.N.A. of corresponding sequence of nucleotides. Similarly, in reverse transcription synthesis of DNA by matching with RNA.

**Translation :** Synthesis of polypeptide chain (of a protein) in the form of a definite sequence of amino acids by matching with an RNA made up of the same sequence of nucleotides.

**Virus :** A member of a group of tiny submicroscopic agents, that causes disease in plants and animals. The body of a mature virus essentially consists of a core of nucleic acid (DNA or RNA) within a protein or protein and lipid coat. They can multiply only inside a living cell. They can be crystallized outside the living host.







# School Science

Vol. XIV No. 3  
September 1976

A QUARTERLY JOURNAL OF SCIENCE EDUCATION

---

## CONTENTS

### 1 EDITORIAL

<i>Ravi P. Bhatia</i>	4	Lev Landau : A Profile
<i>Arun K. Mishra</i>	8	Concepts of 'Ultra-dimensions' and 'Thermodynamics' for Young Cell Biologists
<i>Hem Prakash Lohumi</i>	13	An Inexpensive Device for Determining Refractive Index of a Lipoid
<i>Asha Joglekar</i>	16	Behavioural Study of Fish in an Aquarium
<i>P. Sambasiva Rao</i>	22	A Device to Study the Course of Light Rays through a Prism or a Slab
<i>Kalyani G. Menon</i>	27	Modern Medicine—A Healer or a Disease ?
<i>Puran Chand</i>	30	What Detergents Do

### 34 SCIENCE NEWS

### 56 BOOK REVIEW

### 58 SCIENTIFIC TERMS

COVER : An artist's symbolic representation of the U.S.  
Viking Mission to Mars, showing the spacecraft  
against a backdrop of the Red Planet (Mars).



## TO OUR CONTRIBUTORS

SCHOOL SCIENCE is a quarterly journal intended to serve teachers and students in schools with the recent developments in science and science methodology. It aims to serve as a forum of exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc. should be neatly typed, double spaced on uniformly sized paper, and sent to the Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110016. Each article may not normally exceed 10 typed pages.

The articles sent for publication should be exclusive for this journal. Digests of previously published articles modified to suit the scope and purpose of SCHOOL SCIENCE will be accepted. In these cases the name of the journal in which the original article appeared must be stated.

Headings should not be underlined.

Selected references to literature arranged alphabetically according to the author's name may be given at the end of the article, wherever possible. Each reference should contain the name of the author (with initials), the title of the publication, the name of the publisher, the place of publication, the volume and page numbers.

In the text, the reference should be indicated by the author's name followed by the year of publication enclosed in brackets, e.g. (Passow, 1962). When the author's name occurs in the text, the year of publication alone need be given in brackets, e.g. Passow (1962).

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of postcard size, and should be sent properly packed so as to avoid damage in transit. □

---

## *E d i t o r i a l*

---

THE SMOOTH landing of the unmanned spacecraft Viking I Landed at an ideal vantage point on Mars is a major landmark in space exploration. It is just another incredible achievement of the inhabitants of earth, the blue planet, towards understanding the exact conditions prevailing in another neighbour of the solar system—the red planet. Coming within two decades of the beginning of the space era, it will, of course, remind us how human understanding of the apparently insignificant sprinkles of light in the night sky has been progressing through the ages. It is also a triumph of the indomitable human spirit of enquiry, scientific method and technology over obscurantism and imaginative over simplification. We have been able to befriend and understand some of the heavenly deities. The moon has hosted ordinary mortals from the earth. The deities like the Venus and Mars have confided and communicated more to the scientists than to the hymn-chanting priests.

The Viking Lander have been preceded by at least eight Soviet attempts of which two could land on Mars. Valuable information have also been collected by earlier American and Soviet spacecrafts while orbiting round the planet. The uniqueness of Viking I is its advantageous position from which it has already sent back to earth the most vivid pictures and reliable data. The total project, like any other venture of this complexity and precision, was never a smooth sailing. The launching and landing had to be postponed, a midcourse manoeuvre was delayed, and even after landing, the scooping arm had jammed and other minor troubles had to be corrected. But the project as a whole is a grand success.

The most important objective of the Viking project is to explore the possibility of any kind of life on the Mars. The Viking Lander is equipped with much more intricate and sophisticated gadgets for this investigation than any of the preceding Soviet or American missions. Three types of experiments to detect organic activity has been envisaged. The robot will look for products of respiration, photosynthesis and metabolism. Experiments will continue even

ing the Martian soil into the sterilized incubators inside the Land watch will be kept to observe whether any kind of dormant microbial object starts any biological activity in contact with nutrient. There is a ray of hope that some subsoil microbe might be in a state of suspended animation during the present period of Mars Incubation could make them biologically active again.

One may ask what is the importance of looking for life in life is so abundant and varied in our own planet. This understanding to get an insight into the natural origin of terrestrial life, in a wider context of the properties of matter and the universe. Our knowledge about life on a single case study—the life on earth. The discovery of life on Mars may have a much greater impact on human thinking than the Copernican revolutions. Mars is the only planet in our solar system with any possibility of supporting extra terrestrial life.

From our existing knowledge of earth based life, we can imagine life to exist only in a narrow range of physical and chemical conditions—optimal range of temperature and pressure, absence of severe extremes, presence of oxygen, nitrogen, carbon and water in a 'rocky' planet or satellite.

The stars, such as the sun, are too hot and harsh. Mercury, nearest to the sun, is too hot ( $350^{\circ}\text{C}$ ), and has no atmosphere and is inhospitable. Venus is also inhospitable; four previous Soviet landings have negated the chance of existence of any life there. Jupiter and some of its satellites have possible candidature for hosting life. Uranus and Pluto are too cold. Only Mars has some possibility of sustaining life.

Earth based and satellite based data and pictures suggest that Mars is actually earth's little neighbour, a rocky and metal planet. Compared to earth it is not too cold, has a slightly thinner atmosphere and almost the same day length (24 hours and 39 minutes).

It has ice caps at its poles; and has carbon dioxide, some oxygen and nitrogen in the atmosphere. Mars has volcanoes as on earth but larger and very large canyons and channels. The volcanoes indicate that at least geologically the planet is alive. The channels are river beds through which water (so essential for life) flowed when the atmospheric pressure was much higher and prevented evaporation. With the change of climate, the water and the atmospheric carbon dioxide solidified and formed the polar caps. Consequently, the atmosphere became rarefied and the water vapourized, leaving the river beds dry. Water is still there under the rocks, vapour in the atmosphere and

Many different forms of Martian life can be imagined (based on the terrestrial experience), adapted to the Martian conditions. After all, unusual survival ability in extremely unfavourable conditions or abnormal adaptations is not unknown in our planet. Hot springs, strong acids, arctic seas, abysmal oceans, salt pools have been found to be the happy abodes of terrestrial organisms. Some organisms can even go without water from outside sources—synthesizing it in their bodies.

Yet, the information obtained so far about Mars, indicate that the conditions in the red planet are extremely hostile for life as compared to our planet. Water and free oxygen are in very short supply. There is no ozone layer to filter the harmful ultraviolet rays. Some scientists speculate that this kind of environment could favour the evolution of some microbes or large organisms which could utilize the solid ice or tap the subsoil water. Others could have tried to get water and minerals directly from the rocks. Some organisms could be thick shelled to be able to protect themselves from the lethal solar radiations like the ultraviolet rays.

There is another strong view which insists that Mars is a planet of ebbing life. If life had ever evolved and flourished it must have reached its zenith long long ago when the environment was more congenial. If life is still found in Mars, it must be in degenerating minute forms, surviving precariously, hidden in odd niches here and there. If life found in Mars have properties fundamentally different from that of ours, the basis of biology and science will broaden beyond recognition.

On earth, the immensely diverse living forms have a fundamental unity ranging through chemical composition to the structural and functional adaptation. It is a basic premise of chemical evolution that all living forms have descended from a common ancestor. But what remains a mystery and may be cleared up only from the study of exobiology is whether this unity of pattern emerged out of some fateful biological accidents which occurred in the course of evolution or whether it is an outcome of the intrinsic properties of living matter.

If life is found on Mars, we cannot escape the inference that there is nothing unique about the origin of life on earth and life may be a commonplace cosmic phenomenon. The interaction of cosmic forces would have given rise to similar sequence of events in the countless number of planetary systems in the universe and is still flourishing in billions of planets wherever congenial condition and environment exists. If life is not found on Mars or on any member of the solar system, it would not necessarily discount the above possibilities; but it will be difficult to establish any such view for the simple reason of distance and the communication time involved. □

## Lev Landau—A Profile

RAVI P. BHATIA

*Lecturer, Department of Education in Science and Mathematics, NCERT, New Delhi*

WHEN LEV LANDAU died in 1968, University campuses in the U. S. A. put up signs reading :

### LEV LIVES

So great and widespread was his impact on the twentieth century physics, and so courageous and indomitable his fight against death since the tragic car accident in 1962, that it was hard to believe that Landau existed no more, that he would not adorn the weekly seminars in Moscow in which contemporary physics was discussed and dissected; that he would not lead and guide the many bright students at the Institute for Physical Problems, Moscow, and that he would no more write the brilliant books on Physics that have since become classics.

In this age, when narrow specialization has become the hallmark of science, Landau was an exception who worked in almost all the branches of the theoretical physics as well as in mathematics and chemistry.

His genius flowered early and was, derived partly from his parents. Lev Davidovich Lan-



LEV LANDAU

dau was born in Baku on 22 January 1908. His mother was a doctor and his father was a petroleum engineer. Lev was a brilliant student and finished his schooling when he was only thirteen years old. He was already attracted to the exact sciences and wanted to join the university. But his parents, thinking him to be too young, asked him to join the Baku Economics Technical School. A year later, in 1922, he entered Baku University (now Kirov Azerbayd-zhan State University) where he studied physics, chemistry and mathematics. Although Landau's

first love was physics and mathematics, he retained his interest in chemistry until his death.

In 1924, Landau moved to Leningrad University to study physics. Two years later, at the age of 18, he published his first paper on the theory of spectra of diatomic molecules. A year later, while working on the problem of radiation in quantum mechanics, Landau introduced the concept of density matrix which has now become one of the important tools of statistical physics and solid state physics. The same year, at the age of 19, Landau completed his formal training at Leningrad University, although he was to get his Ph. D. (without defending his thesis) much later, in 1934.

In 1929, Landau got an opportunity of visiting Germany, Switzerland, Holland, Belgium, England and Denmark, and meeting many well-known physicists who were working on quantum mechanics which was developing at an exciting pace. Perhaps his most fruitful stay was in Copenhagen, Denmark, where Niels Bohr, who was the first to theoretically explain the hydrogen spectrum, had attracted the leading physicists of Europe. Bohr was not only a great physicist, but also an outstanding teacher and philosopher. It was Bohr's seminars that played a significant role in the development and consolidation of Landau's genius. Landau always acknowledged Bohr's contributions and considered him to be his teacher and guide.

Later, he used to describe how at that time he was entranced by the incredible beauty of the general theory of relativity. He also described the state of ecstasy to which he was brought on reading the articles by the two German physicists, Heisenberg and Schrodinger, signalling the birth of the new quantum mechanics. He used to say to his student who later became his colleague and friend, E. M. Lifshitz, that "he derived from them not only glamour of

genuine science but also an acute realisation of the power of the human genius whose greatest triumph is that man is capable of comprehending things beyond the pale of his imagination."

On his return from Europe, Landau went back to Leningrad. A year later, he was transferred to Kharkov where he created the Ukrainian Institute of Physics and Technology and produced some of his most significant works, and laid the foundations of theoretical physics at Kharkov. He was transferred again in 1937, for the last time in his life, to Moscow, where he became the director of the theoretical physics division of the Institute of Physical problems, U.S.S.R.

Moscow gave full scope for the wide-ranging interests of Landau. He worked on the theory of plasma oscillations, on electrodynamics, on the origin of stellar energy, on superconductivity and on liquid helium. Helium has some peculiar properties, as was first demonstrated by the British scientist London and the Soviet physicist Kapitza. It becomes liquid at very low temperatures, about  $-271^{\circ}\text{C}$ , and its liquid phase acquires zero viscosity and defies gravity: it has the ability to rise up very narrow capillaries, against the force of gravity. Landau was able to give satisfactory explanation of the properties of liquid helium He-IV, and predict a new phenomenon, that of 'second sound'. He also obtained interesting results for the rare isotope He-III whose physical properties are very much different from those of He-IV.

Recognition and awards came to Landau in abundance. He won the Stalin prize three times the Max Planck medal, and the second London prize in 1961. He was honoured by his election to the Danish, Dutch, and US academies of science as well as to the Royal Society, London, in 1960. In 1962, a few months after the car accident, he was awarded the Nobel

Prize in Physics for his work on the theory of condensed media, especially for the work on the theory of liquid helium.

Although he was a renowned scientist, Landau got into serious trouble with the communist regime of the U.S.S.R. in 1938. He was jailed on suspicion of being a German spy. It was only after Kapitza protested vehemently that Landau was released after one year in the jail. He had become haggard, ill and his hair had become prematurely grey.

Through his love for physics and self-discipline, he overcame his ordeal and turned into a kind and sociable person who was always smiling and helpful. After Landau's death, E. M. Lifshitz wrote of him: "These qualities together with his sober and self-critical mind, enabled him to grow spiritually and evolve into an individual with the rare ability to be happy."

Lifshitz was perhaps the most talented student of Landau. Later, the two became friends and produced a series of monographs on the theoretical physics. The books display Landau's characteristic traits of clarity, brevity and an unorthodox treatment of many topics. This was as a result of Landau's habit of almost never reading any textbook or research journal. But he was up to date in his knowledge which he acquired through discussions at seminars and from his ability to calculate things for himself after being given the briefest of outlines of any new idea. In this, his knowledge of mathematics was very useful. He used to tell his students that he did not remember a time when he was unable to differentiate and to integrate.

Among his other students, the names of A.S. Kompaneys, A.I. Akhiezer, V.L. Ginzburg and A.A. Abrikosov are all well known. If he was helpful to his students, he was also very critical and impatient with any one who tried to talk pompously and waste his time. His stu-

dents had put up a sign on the door of his office :

L.D. LANDAU, BEWARE, HE BITES !

But Landau himself was not disturbed by it. In fact, he added to his own legend by his wit and playfulness. He once said that his name originated from the French spelling L'ane Dau (the ass of Dau). From that day onward, the name stuck ! He was popularly called Dau by his friends and students.

Tragedy struck at the height of his career and recognition. On 7 January 1962, he was going from Moscow to Dubna when the car in which he was travelling collided with a truck coming from the opposite direction. He suffered a fractured skull, multiple internal injuries and was rendered deaf, blind and speechless. His heart, lungs, kidneys were also affected. Yet a heroic struggle was waged by doctors, nurses and friends to save his life. The hospital in which he lay in a coma became a centre to all those—his students and colleagues—who strove to make their own strenuous contribution to help the doctors in their epic task to save Landau's life. Penfield Wilder, the famous neurosurgeon from Montreal was flown to help in his recovery.

After 55 days, during which, clinically, Landau died several times, he was removed from hospital. But he never regained his faculties completely and suffered acute pains. The same year he was awarded the Nobel Prize. While receiving the Noble Award from the Swedish ambassador in Moscow, Landau told him :

I can walk, I can talk, I can read. But I do not have the courage to resume other activities. Today I am an ignoramus. Some-

times violent pains attack me. I can't resist them, not because they are beyond human tolerance, but because I am afraid of them.

Landau suffered for six long years. Despite his distress, he had such a remarkable resilience and mental tenacity, that he was able to guide his students. But he was incapable of doing any

creative work himself. Finally, on 1 April 1968, death came to him. He was mourned not only by his widow and son Igor, by his colleagues and students whom he had taught in Moscow for thirty years, but also by countless number of young students like myself who had never seen him, but had been inspired by his genius and human qualities. □



# Concepts of 'Ultra-dimensions' and 'Thermodynamics' for Young Cell Biologists

ARUN K. MISHRA

*Reader in Botany, Department of Education in Science and Mathematics, NCERT, New Delhi*

CELLS are visible mostly through the help of optical microscope and their organelles usually are seen through the electron microscope. Various organelles of cells, though small in size, perform vital functions. All the food we consume is synthesized by tiny chloroplasts of the green plants and used up by still tinier mitochondria in the cell. The magnanimity of the tasks performed is inversely proportional to the size of the 'performer.' A young, high school cell biologist may know about the structures and functions of the various cell organelles, but he is hardly able to develop an appreciation of the diversity of the size-range on ultra-dimensional scale and the intricacies of the reactions on such minute sites.

Further, the cellular processes, at least many of them, have been resolved in terms of chemical reactions which obey the same physico-chemical principles as applicable to *in vitro* systems. Therefore, a clear understanding of these principles becomes prerequisite of the

teaching of the essentials of cell biology.

In the present article an attempt has been made to show the way to teachers and students as to how to absorb and assimilate these 'so called' hard concepts.

## THE ULTRA-DIMENSIONS

### *The Scales*

We talk of larger organisms in terms of metres (m) the small ones or their body parts in terms of centimetres (cm) and those still smaller but visible through unaided eyes or a dissecting scope in terms of millimetres (mm). These units are all comparatively larger and within the range of the resolution of human eyes. But with the exception of certain giant cells of algae, etc. other cells as well as their parts fall under much lower range of the measuring units thus requiring some mental training for actual visualizations. These ultra or micro-dimensions recur very frequently in cell biological literature. It is not just enough to know that a micron ( $\mu$ ) is  $10^{-3}$  mm and an angstrom ( $\text{\AA}$ ) unit is  $10^{-7}$  mm. The mind must be able to carry out a mental abstraction from the sub-visible dimensions to visible units and realize the need and utility of finer resolutions and magnifications. The earlier is this achieved by the learner the more effective it would be in assimilating the concepts and principles of cell biology. There may be several ways in which this could be accomplished. Indeed, each learner would develop his own mental process to achieve this visualization, but a few approaches are suggested here which would particularly aid an average learner. One way could be to discuss and work out such

problems as how long a metre scale would look if it were reduced one thousand times, and then again, to one thousand times. The process may be repeated till one reaches the value of an Å or a nanometre (nm). Similarly, an exercise may be carried out as to how much two dots as close 1 Å must be magnified so that they are seen clearly apart through unaided eyes. At this stage the resolving power of the human eyes may be given as about 1/5 mm. It is possible that some learners already possess this sense of reduction-magnification, if already trained in mathematics. If so, one could do the following exercise straightaway on the basis of his earlier knowledge of the names of cell components and the ability to draw histograms. The following set of data or a similar set may be tried out as a classroom activity:

Cell diameter	100 $\mu$
Nuclear diameter	15 $\mu$
Chloroplast length	5 $\mu$
Mitochondrial diameter	2 $\mu$
Lysosome	1 $\mu$
Cell wall width	2 $\mu$
Plasmalemma width	100 Å

While doing this exercise, the dimensional proportions involved would come rather lucidly to the learner's mind and he will soon start pondering about the subcellular structures and phenomena. One can well imagine what sort of problems will be encountered, amusements and thrills derived, if one tried to carry this exercise further to drawing a scaler sketch of a typical cell after learning more about the cell organelles.

### *Magnification and Resolution*

As already evident, the organisms and their organelles are observed at three levels of resolution which are: a fraction of mm, micron and Å corresponding to the resolving power of the human eyes, the optical microscope, and the electron microscope. With each of the three tools, of course, exists not one definite value but a range. The word resolution and magnification are often erroneously understood and used. Small objects, just visible through unaided eyes, can be photographically enlarged several hundred times. But shall we see any details comparable to what could be seen under an optical microscope? If that were possible, microscopes could have been done away with as tools of observation. Therefore, the utility of the microscope lies in its property to resolve two close-by points apart from each other and in this the optical microscopes are about 100 times better than our eyes. The magnifying power of the instrument functions simply to bring the points already resolved to the level of the resolving power of the eyes. Therefore, the magnifying power of the optical microscope is of the order of a few hundred times only. The wave-length of light and the properties of glass lenses do not permit much betterment of the resolving power of the light microscope.

The resolving and magnifying powers of the electron microscopes are based on similar considerations. The best resolutions available in the electron microscope are of the order of a few Å units and the magnification in these works to bring the resolved points on a photographic plate to more than the limit of the resolving power of the eyes, i.e. of the order of few hundred thousands.

## ENERGY AND CELLULAR PROCESSES

*Why Thermodynamics in Biology?*

No one can logically question that for every 'work' to be done certain amount of 'energy' must be spent. "I neither have time nor energy to waste..." is a commonly encountered expression among the educated people. The biologists know that the energy-work relation applies not only to machines but also to man and other organisms. For instance, man performs 'work' through his limbs and the muscles inside, the muscles derive energy ultimately from the food consumed by the man. The foods are made of definite chemical molecules and are broken down into other molecules, thus releasing their energy which our muscles use. It naturally follows that the bio-energetics must be conceptualized at the molecular level. The thing to realize at this stage is that basically the apparent expenditure of energy has molecular basis, that energy exchanges do take place during the process of chemical reactions and that no system, physical or biological, is 100 per cent efficient in the sense that all the energy released in a reaction is available to do work, and further, that a part of it always becomes unavailable for doing work (Entropy).

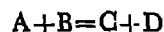
Just as the ultra-dimensions should be clearly visualized for the study of cell biology, simple mental images must also be built to understand the total energy (Enthalpy), energy available to do the work (Free Energy) and the third thermodynamic quantity (Entropy) which is not available for doing work. For a biology teacher these terms and concepts may appear new but the need to understand the energy transfer processes not only in the cells but also in the biosphere necessitates a bit of effort made in this direction. It is made quite explicit here that

in introducing these terms and concepts it has been kept in mind that no prior knowledge of physics or chemistry is required but those having some background would not only find it easier to comprehend but will be able to relate better their previous understanding to its applications in cells.

For the present level of the subject matter, the theoretical discussions, mathematical derivations, and numerical calculations will be avoided. It is only being attempted to help the learner to perceive these thermodynamic quantities as would aid them in visualizing the energy transfers, directions of reactions and the irreversibility of the biological processes in the light of these definite physico-chemical principles as being applicable to biological systems.

*Total Energy*

As the life processes are now seen as an integrated sum of physico-chemical reactions, we can say that a number of reactions that occur in the protoplasm are made of components like :



where A and B are reactants and C and D are the products of the reaction. As already mentioned, each molecule has its own built-in energy. Hence, when any two molecules react to form any product or products, some energy transfer is definitely involved. If the reactants and products of the above reaction could be taken in isolation and physically burnt to obtain a certain number of calories, for each side of the equation we shall get the total energy content (Enthalpy) for either side of substances. Let us say that (A+B) gives us X calories and (C+D)

gives us Y calories upon combustion, in this way. Then  $\Delta H$  (delta H or change in enthalpy or the heat of reaction, all synonyms) will equal Y-X calories,  $\Delta H = Y - X \text{ cal.}$

### Free Energy

As will be seen in our later discussion of entropy,  $\Delta H$  is not necessarily (ideally never) the indicator for the direction of a particular reaction. In every reaction, a component of it becomes unutilizable to do 'work'. Therefore, the remainder of the energy released in a reaction that is actually available to perform work is termed 'free energy'. It is easy to imagine free energy with the analogy of the potential energy of a body kept at a height from the ground. The potential energy of such a body depends upon its vertical distance from the ground. The stretch of a spiral spring or the voltage of electricity may be other analogies. Although the free energy (F) of a molecule depends on its constitution it is not measurable except, in terms of  $\Delta F$ , or change in free energy in course of a reaction or a process. So, for our example.  $A + B = C + D$ ;  $\Delta F$  is also a measurable quantity. If the  $\Delta F$  (i.e.  $F_{\text{react}} - F_{\text{prod.}}$ ) is a negative quantity the reaction will move spontaneously to the right and useful energy will be available for the performance of work 'by' the system. Such a reaction is known as exergonic reaction. For the reaction to proceed in the reverse direction (endergonic reaction) energy must be supplied from outside, i.e. work must be done 'on' the system.

### Entropy

But as pointed out, not all such energy trans-

fers are one hundred per cent efficient and for each reaction, a fraction of it becomes unavailable for doing work. The lost energy is due to the intra-atomic movement of electrons, intramolecular movements of atoms; and intermolecular movements with relation to each other. It follows that the faster the movements the greater will be the unavailable energy.

Entropy is a measurable quantity though difficult to imagine. Besides, in contrast to enthalpy and free energy, it is not an energy form. It becomes an energy form only if multiplied by T (absolute temperature).

$$\text{or, } E (\text{unavailable}) = T S$$

The following example will help us visualize this quantity better. For any well ordered system or structure, the entropy is the minimum. The row-wise arrangement of desks in the classroom means less entropy than the same classroom completely disorganized by the unruly behaviour of children. Someone has to put in extra work to bring back order to such a disorderly system. If a few of these desks are broken down then a carpenter has to do further work first to re-assemble them before the desks could be put in rows again. It would thus mean that larger the number of possible arrangements of the components of the classroom the greater would be the entropy. Further, if some of the desks are damaged to such an extent that even any repair becomes impossible, i.e. if the damage is irreversible, then the increase in entropy is further enhanced. Therefore, increase in entropy is not only associated with *disorderliness* but also with *irreversibility*, increasing in each condition.

### The Relationship between H, E, and S

Being already aware of these three para-

meters we can sum up their interrelations as follows :

$$H = F + T \Delta S$$
$$\text{and } F = H - T \Delta S$$

### *Entropy and Life*

Entropy can also be seen as a philosophical concept not just for the physico-chemical reactions or life processes but any range of socio-economic or political events since order and disorder are common phenomena all around. In the case of socio-economic and political phenomena, the role of administration is to reduce entropy. The living organisms and life processes are often characterized as giving rise to 'negative entropy'. This is by virtue of their

being highly regular and orderly. When large number of amino acids join at random to form a protein molecule of highly ordered nature the system is actually proceeding from larger number of possible assortments to a definite sequence. Here the thought or negative entropy comes into picture. The protein synthesis in cells is the 'key' to biological organization and function. Similarly, when smaller molecules like water and carbon dioxide give rise to orderly organic molecules, the work must be done on the system, free energy provided and the entropy reduced. The energy of the sun, through photosynthesis, makes it all possible.

The arrow of life moves in one direction, i.e. the direction of time, it is irreversible and the loss of life means increase in entropy.  $\square$

# An Inexpensive Device for Determining Refractive Index of a Liquid

HEM PRAKASH LOHUMI

*Jainwal Building, Kathgodam, Nainital*

AT SCHOOL level, the methods of determination of refractive index of a liquid are based on one of the following principles :

- (a) Using a rectangular hollow chamber filled with the liquid and determining  $i$  and  $r$  angles by the pin method.
- (b) Using a hollow prism filled with the liquid and determining minimum deviation angle.
- (c) Measuring the real depth  $h$  and apparent depth  $h'$  of a liquid column and using the relation,  $\mu = h/h'$ .
- (d) Using a concave mirror and deducing the real radius of curvature  $R_x$  and apparent one  $R_y$  when some liquid is put in it to find as the ratio  $R_x/R_y$ .
- (e) The total internal reflection method using an air film.

Method (a) is the most direct in principle, but does not lead to resonable accuracy.

Method (b) is too terse for the beginner. Method (c) is good and simple in principle, but the difficulties are with the measurement of angle and the fact that one depends on a single observation. It is also difficult to explain that the glass strips enclosing the air have no effect.

Thus the commonest methods actually in use are (c) and (d). Method (d) has the advantage that a very small quantity of liquid is enough for the measurement. But since several concave mirrors cannot be given, there is no variable parameter available. Also the essentially vertical arrangement is inconvenient in setting and in measurement. In method (c) one can easily vary the depth of the liquid column  $h$  and get several readings for  $h/h'$ . Hence, it is an instructive experimental exercise for the students.

However, in measuring  $h$  and  $h'$ , the present practice is to use a microscope with a vertical travelling arrangement. This increases the cost and also shifts the attention to the microscope, so much so that the method is called 'microscope method' rather than the 'apparent depth method'. Another difficulty is seldom noticed : the maximum  $h$  can be equal to the focussing distance of the microscope and thus  $h$  can seldom exceed 20 mm. Accuracy then requires that we use the vernier scale to measure up to 0.1 mm., but practical experience shows that the setting can hardly be repeated to better than 1 mm. Thus for water if  $h=20$  mm. and  $h'=15 \pm 1$  mm. giving error about  $\pm 6\%$ . On the contrary this simple device which essentially measures  $h$  and  $h'$  in a horizontal arrangement, does not use a travelling microscope and permits variations of

h over a very wide range up to 200 mm. For these reasons the device is very convenient, most inexpensive and more instructive.

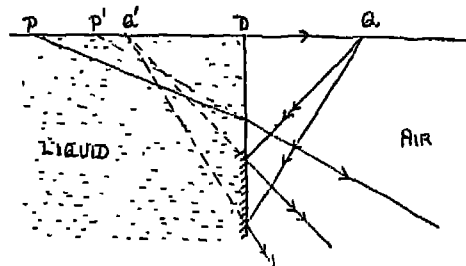
is variable because the inner box can be slid and  $P D$  is variable because screen carrying  $P$  can also be slid.

### THE DEVICE

It essentially consists of two boxes A and B both open at the top (Fig. 1). Box A is liquid tight and can slide inside box B along its length. Ends C and B of the outer box are made of plain glass plates; end D of the inner box is made of half-silvered glass plate (reflecting surface facing towards C). All the other sides may be made of metal sheets. The dimensions of box A may be 8 cm.  $\times$  86 cm.  $\times$  20 cm. Box B may be nearly 40 cm. in length, and its width is just enough to let box A slide inside it. A straight vertical line  $P$  is marked on a screen hanging in box A and capable of sliding along its length. A scale over the upper edge of box B can measure the locations of  $P$  and  $D$ .

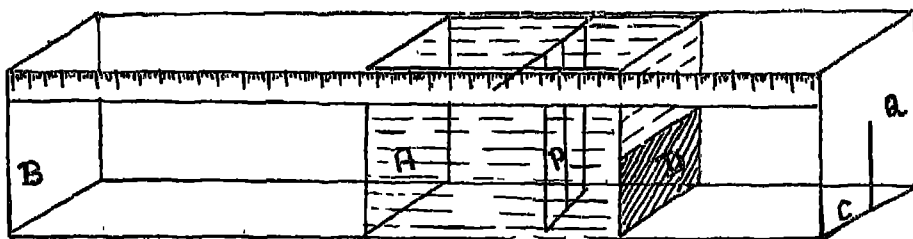
### The Procedure and Principle

The inner box is filled with the experimental liquid. The mirror on face  $D$  gives an image of  $Q$  at an equal distance behind  $D$ . The image of  $P$  as seen through the liquid is at a distance  $P D/\mu$  behind  $D$ . If these are made to coincide, as judged by 'no parallax' method, then we have  $Q D = P D/\mu$  therefore  $\mu = P D/Q D$ .  $Q D$



The ray diagram below shows the principle. The image of  $P$  seen through the water and transparent part of  $D$  is at  $P'$  while the image of  $Q$  as seen by reflection at the mirror over  $D$  is  $Q'$ . If the box is slid,  $P D$  remains fixed and hence  $P'D = (PD/\mu)$  remains fixed, but  $Q D$  changes and hence  $Q' D (\neq Q D/\delta)$  changes. On the other hand if the box is kept and the screen carrying  $P$  is slid, then  $Q'D (=Q D/\delta)$  remains fixed and  $P'D (=P D/\mu)$  changes. The experimental setting has therefore, two alternative for making  $Q'$  coincide with  $P'$ . Since the images of  $P$  (through water) and of  $Q$  through the mirror are in a continuous vertical line the coincidence can be judged accurately by the 'no parallax' method.

The setting and scale reading insure an



accuracy of  $\pm 2$  mm., and if the length P D is about 100 mm. the accuracy is nearly 2%.

A typical set of readings actually taken with the apparatus is given in table 1.

TABLE 1

S. No.	Q D	P D	$\mu$	Mean $\mu$
1	8.0 Cm.	6.1 Cm.	1.31	1.33
2	10.3 „	7.7 „	1.34	
3	12.0 „	9.0 „	1.33	
4	14.1 „	10.4 „	1.35	
5	15.8 „	11.9 „	1.33	

### Advantages

1. The apparatus keeps the attention on image formation and gives directly the real and virtual depths.
2. The handling and adjustment are easy. It provides a large range of variation in lengths and there are two alternative ways of setting.
3. The cost of the apparatus is very low and it can be assembled and/or repaired in any laboratory easily. The cost is below Rs. 20

as compared with Rs. 500 for the microscope method device.

4. The result comes out more accurately than in the microscope method because (i) large lengths are used, and (ii) 'no parallax method' is far more sensitive than the 'sharp focus' adjustment used in the microscope method.

5. If the outer box also is liquid-tight one can fill the liquid in the outer box and have an alternative way for the experiment. One can also fill different liquids in the two boxes and find  $\frac{\mu_1}{\mu_2}$ .

### Versatility

The arrangement can be modified to do many other experiments usually done on an optical bench with the addition of liquid as the medium instead of air. Image formation in concave as well as convex mirrors and in convex as well as concave lenses can be studied and the mirrors/lenses can be suspended in any liquid.  $\square$



# Behavioural Study of Fish in an Aquarium

ASHA JOGLEKAR

Pool officer, Department of Education in Science and Mathematics, NCERT, New Delhi

BIOLOGY allows us to understand the living world and our place in it. In conventional biology teaching, however, dead animals and plants were used for a long time to teach life processes. Recent developments in the teaching of biology emphasize more on the use of living organisms to provide the student the opportunity for personal experience in observing and investigating living organisms and their life processes (Kelly and Wray, 1975). Various living organisms can be procured and maintained successfully in a school laboratory and the fish is one of them. It can be used in many experiments to teach various life processes. *Colisa fasciata*, the Bengal Gourami was used here to see how we can know certain facts about fishes in general and Gouramies in particular.

Let us first get familiar with our specimen. This is a moderate size fish, growing up to 5"

in length (Fig. 1). The body is olive with 10-11 dark cross bands. The phosphorescent blue

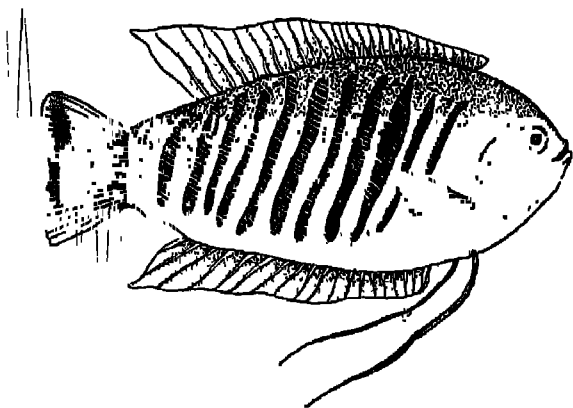


FIG. 1.

and orange colouration of vertical fins, specially in the adult males makes it an attractive fish.

Fin formula is D XV—XV+12-13, P. 9-10 A. XVI+13—16 VI C. 16 (D=Dorsal) fin P=pectoral fin, A=anal fin, V=ventral fin C=caudal fin.

First half of dorsal and anal is spiny and these are most colourful in males. They are of phosphorescent blue colour with orange margin. Ventrals are in the form of long thread like feelers and are orange in the male and white in the female. Eight specimens of the species were procured from a ditch near Jamuna bridge and kept in a community tank, 36" × 12" × 12" in size (Fig. 2).

## Locomotion

Two primary methods are employed by fishes to move through water: (i) Body movements due to alternate contraction and expansion of lateral muscles (as is the case in the majority of animals) namely, myomeres; (ii) Movement through fins.

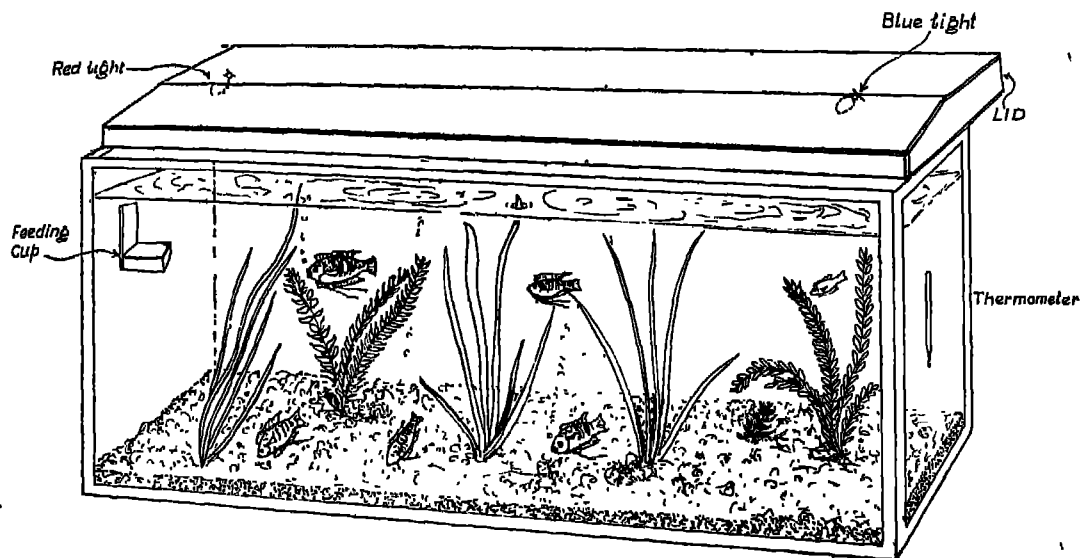


FIG. 2.

*Feeding*

Gouramies propel themselves forward with beats of their pectoral fins and tails. The body is deep and cannot produce rapid undulations like other fishes. They are slow-movers and often the tail is held straight. Pectorals are important organs of movement and are in action even when the fish is hovering (standing still in coater). When the fish is chased with a hand net, it swims faster with the tail providing a strong propulsive force. In a smaller space the fish employs the body movement which is never rapid.

To find out whether pectorals are indispensable to a fish or not, a thread was tied over the pectorals and the fish was replaced in water. It was unable to balance itself and it sank to the floor in head up position. Similarly, tying of the vertical fins caused the fish to float in a head-up posture. This tying of fins, however, shocked the fish severely and it remained at bottom of the tank most of the times.

Different fishes have different food choices. The first stage in the life cycle of a fish is completed at the expense of food reserves. During the process of development changes occur in its food, which are connected with the change in structure. Adult fishes may be either; (i) Herbivorous and detritophagic; feeding on plant matter or withering matter; (ii) Carnivorous; feeding on invertebrates, etc., and (iii) Predatory feeding on fish.

Many fishes have evolved organs, by means of which they seek their food. Predatory fishes capture their prey with the help of eyes and lateral line. Benthophagic fishes (Feeding on bottom) develop tactile organs as feeders in Gouramies and Barbels in silurids and cyprinids. The shape and structure of mouth also helps in understanding the feeding habits of a fish. Predators have large or medium grasping mouth

with sharp teeth on both the jaws. Carnivores have crushing mouth with powerful teeth. Herbivores have usually small protracile mouth with small conical teeth. These basic types of mouth structures are related to each other by a number of transitional types.

Gouramies have a small protrucible mouth, terminal or semidorsal in position. The jaws have minute conical teeth. It feeds on aquatic plants, insect larvae, tubifex worms and even fish eggs and fish larvae. In an aquarium it also thrives well on boiled egg, chopped earthworms and dry fish-food available in the market.

Fishes which have not been fed for some time can be seen systematically searching for food moving around, extending their feelers in

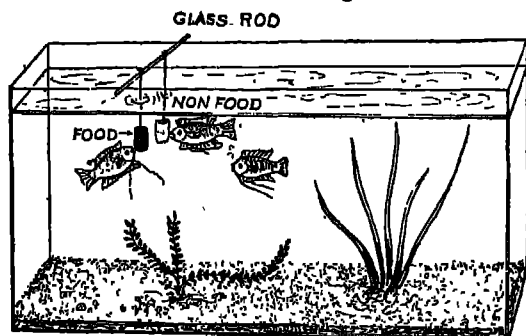


FIG. 3.

all directions. They have also been found searching the tankfloor in a head-down position. Big food particles which could not be taken as such are eaten away bit by bit in this posture (Fig. 2).

Can these fishes distinguish between food item and non-food item? A small experiment was conducted to know about the gustatory response of fish (Durve, 1969).

In two small cloth bags of the same size equal amount (2 gm) of dry food and sand was filled (food in one bag and sand in the other). The open ends of the bags were also stitched later. The two bags were then tied to a glass rod with long threads, so that they hanged. This rod with two bags was then kept on a glass tank in which three pre-starved specimens of *colisa fasciata* were kept (they were starved for 24 hours) (Fig. 3). They were watched for about 30 minutes and it was noted down that how many times a fish touched down each bag. (Fishes were marked with coloured pencil on scales. When the fishes appeared to be exhausted, they were given food and the experiment was repeated on the third day. Table 1 shows the results of this experiment which indicates that Gouramies can differentiate between food and non-food to a certain extent.

TABLE 1

Date	Fish (length)		No. of strikes to bag containing food	No. of strikes to bag containing non-food
24.6.76	No. 1	4.6 cms.	12	10
	No. 2	5.3 cms.	13	7
	No. 3	6.0 cms.	13	6
26.6.76	No. 1		17	8
	No. 2		18	6
	No. 3		18	4

*Vision*

Fishes sense the light with their eyes and light sensitive spots. As compared to man and other terrestrial animals, the fish is more short-sighted; morphologically this is determined by the lens being more spherical.

The eyes of fish undergo considerable modifications in ontogeny; young fishes which usually feed near the surface have the greatest sensitivity for light in the lower part of the eye. When the fish starts feeding on benthos (bottom feeding) the sensitivity of the upper part increases.

Gouramies have moderately developed eyes and can chase their prey or food very actively. Body colouration tends to alter with the change in surroundings. A small experiment was conducted to find out whether this alteration in colour also occurs when eyes are not working. Two fishes were kept together in a tank with black sand and turbid water. One of these was blind due to certain injuries (eyes, however, can be closed using stick-fast strips), the other was normal. The colouration was drab. These were transferred to a tank of clean water with

white sand. After about ten to fifteen minutes, the fishes were observed again. Colouration in the normal specimen became lighter and brighter whereas that in the blind specimen remained unaltered. It is well known that colouration of a fish varies during its individual development. It changes when a fish moves from one habitat to other. Young Gouramies are almost transparent, when they are surface feeders, difficult to see against a background of mirror surface. The colouration becomes dark in the adult, olive with dark bands suitable for muddy, weedy ditches.

It is said that the majority of fishes can distinguish colour (Nikolsky, 1963). To verify it, Gouramies were given food only after switching on a red light. The fishes learned to rush to the feeding cup when the red light was switched on, within ten days. Fishes like *Barbus* took eleven to twelve days whereas *Ophiocephalus* was the one which took maximum time, i.e., 17 days. Sometimes the green light was also switched on and on food was served. They also learned to neglect green light. Table 2 shows the results of the above experiment.

TABLE 2

<i>Serial No. of Days</i>	<i>Response when the light was switched on</i>
First day	Startled, tried to avoid light, hid in remote corner
Second day	"
Third day	"
Fourth day	Slowly advanced " towards the feeding-cup after about 30 to 40 seconds, when noone was around
Fifth day	Advanced towards the feeding-cup after about 10 seconds.
Sixth day	"
Seventh day	Time taken to reach the feeding-cup was about 10 to 15 seconds. Movement was normal
Eighth day	Actively moved here and there and reached the feeding-cup in 8 to 10 seconds
Ninth day	"
Tenth day	Rushed to the feeding-cup within 5 seconds

A second experiment was conducted to see whether these fishes distinguish one colour from the other or not? The colour of the electric bulb was changed by wrapping the cellophane paper of different colours in the following order: red, orange, yellow, green and blue. Each colour was retained for a week and after switching on the light food was given. Change in the colour did not show any change in behaviour of fishes and they kept on rushing to the feeding-cup in spite of the change in colour. However, when after blue the colour was changed again to red, the fishes appeared startled for some time but resumed their normal behaviour within 5 to 10 minutes.

### *Respiration*

Normally fishes respire by taking water through mouth and passing it out via gill clefts. When water is taken in, the gill cover is tightly closed, when it passes out the mouth remains shut. However, continuous flow of water is always maintained. Oxygen dissolved in the water is absorbed by the blood in minute capillaries of gill lamellae.

Gouramies respire in two ways. When submerged in water they use their gills for respiration. However, they often come to surface for aerial respiration. A special accessory respiratory organ in the form of paired outgrowths of branchial cavities, walls of which are permeated with minute capillaries, serves the purpose (Norman, 1962).

The rate of breathing differs in various species, but a deficiency of oxygen and too much carbon dioxide in blood causes an acceleration in the breathing movements. The rate of breathing in various fishes can be

noted down in a clean well-aerated water and effects of changes in the water conditions can be studied. The fish, however, should be given ample time to settle down and resume its normal activities.

The rate of breathing in Gouramies is 40-45 rhythmical flappings/minute.

### *Growth Rate*

A characteristic feature of the growth rate of a fish is its periodicity. In certain seasons of the year a fish grows more rapidly, in the others it grows more slowly. It also depends on the availability of the food and space. The aquarium-reared fishes are always smaller in size than their counterpart in the ponds and rivers.

Two specimens of Gouramies were kept on different diets, e.g. vegetarian and non-vegetarian and their growth was studied. The length and weight of the fish were noted down prior to experiment. The fishes were then given measured quantity of food (1 gm) every day and after a month, the length and weight were noted again. The results are depicted in Table 3, which shows that the fishes on the diet of animal origin grew faster.

### *Regeneration*

Regeneration is not very common in fishes. However, thread-like appendages, viz. barbels, feelers, pectoral filaments, etc. do show a capacity of regeneration.

In *colisa fasciata* feeler was cut and the regeneration process was watched. The feeler regained its original length in one and a half month. Table 4 shows the results of this experiment.

TABLE 3  
SHOWING GROWTH IN FISHES WHEN THEY ARE KEPT ON DIFFERENT DIETS  
*Normal Diet (Mixed sort)*

<i>Initial length</i>	<i>Initial weight</i>	<i>Final length</i>	<i>Final weight</i>	<i>Increase in length</i>	<i>Increase in weight</i>
4.5 cms.	1.85 gms	4.6 cms	2.6 gms.	0.1 cms.	0.75 gms.
<i>Diet of vegetative origin (Aquatic plants, flour, crushed vegetables)</i>					
5.2 cms	2.0 gms.	5.5 cms.	2.7 gms.	0.3 cms.	0.7 gms.
<i>Diet of animal origin (worms, insect larvae, boiled eggs, etc.)</i>					
5.0 cms	2.2 gms.	5.5 cms.	3.3 gms.	0.5 cms.	1.1 gms.

TABLE 4  
SHOWING THE REGENERATION OF FEELER

<i>Initial length of feeler</i>	<i>Length after cutting</i>	<i>Growth in 1st 10 days</i>	<i>Growth in next 10 days</i>	<i>Growth in next 10 days</i>	<i>Growth in next 10 days</i>	<i>Growth in next 5 days</i>
3.7 cms.	1.5 cms.	length of feeler=1.6 cms. Growth =0.1 cms	length of feeler=2.1 cms. Growth=0.5 cms	length of feeler=2.6 cms. Growth =0.6 cms.	length of feeler=3.2 cms. Growth=0.6 cms.	length of feeler=3.7 cms. Growth =0.5 cms.

### Conclusion

These and other such experiments help children to know and understand important biological concepts which otherwise appear complicated.

Fishes can be obtained and maintained in a school situation without much difficulty. Any water tight container, wide-mouthed bottles, pickle jars, enamelled pans, etc. may be used satisfactorily to keep fishes. Sand is usually

available everywhere. However, soil can be used as a medium in which plants anchor and animals burrow. Ordinary tap water, well water or water from streams may be used satisfactorily. Plants such as hydrilla, vallisneria and ceratophyllum are excellent oxygenators, grow rapidly and form good food for fishes. These can be obtained easily from ponds and ditches. Aerator is also not an absolute necessity, if the surface area is more than artificial aeration is not required.

### REFERENCES

- DURVE, V.S., "Some Observations on the Conditioned Responses in the Fingerlings of the Milk Fish, *Chanos chanos* (Porskal)," *Proc. Ind. Acad. Sci.*, 68 pp. 70-78, 1968  
 KELLY, P.J. AND J.D. WRAY, *Educational Use of Living Organisms*, Univ. Press, London, pp. 188, 1975.  
 NIKOLSKY, G.V., *The Ecology of Fishes*. Academic Press, London, 1963  
 NORMAN, J.R. AND GREEN WOOD, P.H., *A History of Fishes*, London, 1962

prism-table and two arms  $R_1$  and  $R_2$  (each about 2 cm. in width), which can be rotated on

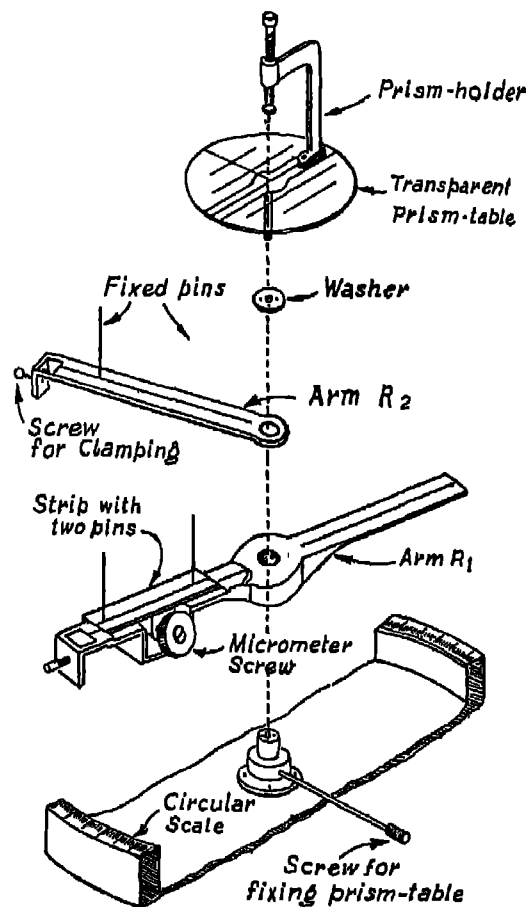
### PARTS OF THE INSTRUMENT

## A Device to Study the Course of Light Rays through a Prism or a Slab

P. SAMBASIVA RAO

*Physics Department, Engineering College, Anantapur*

A NEW device to study the course of light rays through a prism or slab has been developed. This eliminates geometrical construction needed in the study of the course of light rays through a transparent material (prism or slab) by 'pins method' (a conventional method of fixing pins on either side of the transparent material, kept on a sheet of paper, to trace the path of light rays), and enables one to measure the required angles more accurately. Though the device is similar to a spectrometer, a known alternative, the new design has its own advantages and is very useful in schools and junior colleges. Up to the intermediate level, and sometimes at the degree level, students find it difficult to handle a spectrometer. This new and simple design requires no intricate adjustments, as in a spectrometer, and is easy to operate.



### MICROMETER ARRANGEMENT

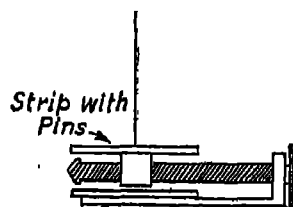


FIG. 1.

### DESCRIPTION

The instrument consists of a transparent

a horizontal plane about a vertical axis through the centre of the prism-table. The ends of arms move over a circular scale (about 25 cms. in diameter), which is divided into degrees and minutes. On each arm, a line is marked centrally along the length of the arm and two pins are mounted vertically on the line, with a suitable distance of separation between them. The line joining the pins indicates the path of light rays. The arm  $R_1$  is extended on the other side, as shown in Fig. 1, so as to make measurement of any angle easy. A micrometer-screw arrangement with a projected head is made for lateral displacement of the strip (a part of arm  $R_1$ ) containing two vertical pins. Screws are provided at the end of the arms for clamping purposes.

The prism-table (about 8 cms. in diameter), the most important part of the instrument, consists of a transparent circular glass-plate with etched parallel lines on either side of one of its diameters and a radial line perpendicular to this diameter. The glass plate is fixed at its centre, along its diameter, symmetrically on a metal supporting strip attached to a vertical rod. The prism-table also can be rotated about a vertical axis and can be fixed at any position by means of a screw. A prism-holder is fixed on the prism-table.

#### EXPERIMENTS WITH THE INSTRUMENT

The principle behind the following experiments is same as the students had been following in schools and junior colleges. But the use of this novel design in conducting the experiments, eliminates the normal drudgery of the 'pins method.'

(i) *Angle of the Prism (A).* The arm  $R_1$  is fixed at a convenient position. The radial line, etched on the prism-table, is made coincident

with the central line marked on arm  $R_1$  and the prism-table is clamped. The prism is placed on the prism-table in such a manner that the ground face BC of it, is along one of the lines drawn parallel to the diameter of the prism-table; and the plane AB of the reflecting surface passes through the centre of the prism-table, as shown in Fig. 2(a). The images of the pins of  $R_1$  reflected at the face AB are observed. Looking along its length,  $R_2$  is turned until the pins

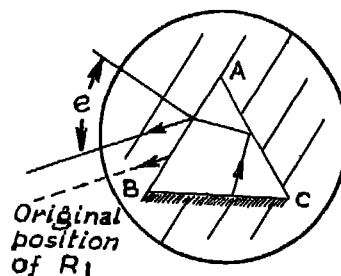


FIG. (2a)

on it coincide with the reflected images and all the four pins appear in a line. At this position the reading ( $\theta_1$ ) on the circular scale is noted. Without disturbing the prism-table, the prism is laterally moved so that the reflecting plane AC now passes through the centre of the prism-table. This is indicated by the dotted lines of Fig. 2(a). Proceeding as in the previous instance, the reading ( $\theta_2$ ) on the circular scale is noted. The difference between the readings ( $\theta_1 \sim \theta_2$ ) gives twice the angle ( $2A$ ) of the prism.

(ii) *i-d curve.* The conventional 'pins method' demands more time in completing this experiment, as the student has to follow the entire geometrical construction, for each set of readings (angles  $i$  and  $d$ ). But with the new device, just by rotating  $R_1$ , we can change the angle of incidence ( $i$ ), and by turning  $R_2$  and coinciding all the four pins, angle of deviation ( $d$ ) can be measured directly, with little difficulty, as the



foregoing procedure indicates.

The arm  $R_1$  is fixed at a convenient position and the reading is noted. The radial line is made coincident with the central line marked on arm  $R_1$  and the prism-table is clamped. The reflecting surface AB of the prism is arranged along one of the parallel lines on the prism-table, as shown in Fig 2(b). Now, the radial line is normal to AB. The arm  $R_1$  is released and is turned through a known angle towards

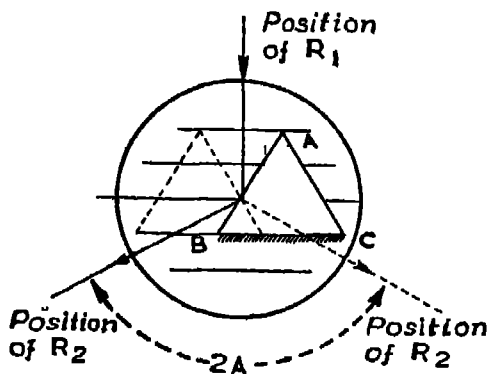


FIG. 2(b)

the ground face of the prism. This angle between  $R_1$  and the radial line gives the angle of incidence ( $i$ ) of the light ray at the prism. Looking on the other side of the prism, and observing along its length,  $R_2$  is turned until the pins on it lie almost parallel with the refracted images of the pins on  $R_1$ . The micrometer-screw, provided to arm  $R_1$ , is turned for lateral displacement of incident ray (which makes no difference in the angle of incidence) until all the four pins appear in a line, to satisfy the second law of refraction or Snell's law. The readings of  $R_2$  and  $R_1$  on the extension side on the circular scale are noted. The difference between the readings gives the angle of deviation ( $d$ ) for the corresponding angle of incidence ( $i$ ). Similarly, varying angles of incidence, corresponding

angles of deviation are obtained. A graph between ' $i$ ' and ' $d$ ' shows; the variation of angle of deviation with the increase of incidence.

(iii) *Angle of minimum deviation ( $D$ )*. The measurement of the angle of minimum deviation ( $D$ ) with 'pins method' is not at all possible. On the other hand, most of the students find it very difficult to get this position of minimum deviation with a spectrometer. Evidently, the new design deserves full credit, in this respect, because ' $D$ ' can be measured without strain and the positions of  $R_1$  and  $R_2$  make the student visualize the condition for minimum deviation, as is evidenced below.

Symmetrical arrangement of the prism at the centre of the prism-table is required, since at minimum deviation, the light rays pass symmetrically through the prism. The prism and arms  $R_1$  and  $R_2$  are arranged as shown in Fig. 2(c). Looking along the length of  $R_2$ , the arms  $R_1$  and  $R_2$  are turned, slowly and simultaneously, in such a direction, until all the four pins appear in a straight line. (Here lateral displacement of the pins is not necessary). The angle of deviation obtained at this positions called the angle of minimum deviation ( $D$ ). The refractive index of the material ( $\mu$ ) of a prism can be calculated from the usual relation,

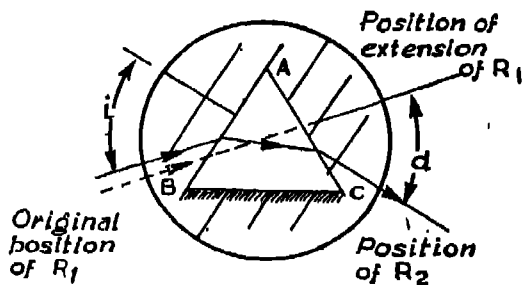


FIG. 2(c)

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

(iv)  $\mu$  for small angled prism. The arm  $R_1$  is fixed at the position, where the central line of it coincides with the radial line. The small-angled prism is arranged as shown in Fig. 2 (d). The angle of deviation ( $D$ ) is measured by adopting

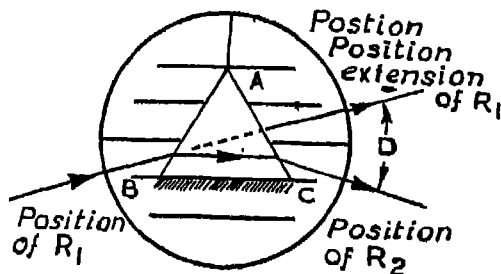


FIG. 2(d)

similar procedure given in the experiment (ii). The refractive index of the material ( $\mu$ ) of the prism can be calculated from the relation,

$$\mu = \frac{\sin(A+D)}{\sin A}$$

(v)  $\mu$  by total internal reflection. With a spectrometer, the measurement of angle of the emergence ( $e$ ) of a ray suffering total internal reflection in a prism, is cumbersome and tedious. Moreover, with a spectrometer the evaluation of ' $e$ ' is not direct. However, with the new design the measurement of ' $e$ ' is much simpler and direct, according to the procedure given below.

A vertical, central line is drawn with pencil on the ground face of the prism. This line acts as light source for the present experiment. The arm  $R_1$  is fixed at a convenient position, and the reading ( $\theta_1$ ) is noted. The prism-table is clamped, after coinciding the radial line with the central line marked on arm  $R_1$ . The reflecting surface AB of the prism is arranged along

one of the parallel lines on the prism-table, as shown in Fig. 2 (e). Now, the radial line is normal to AB. (For the determination of the angle of emergence ( $e$ ) from both sides of the prism,

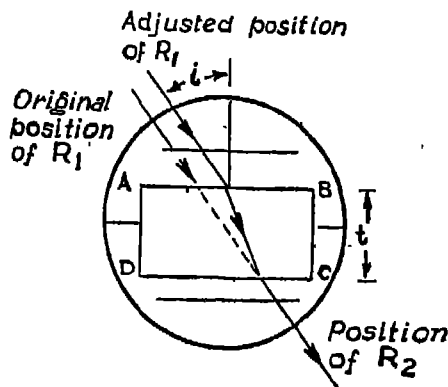


FIG. 2(e)

arm  $R_2$  is not necessary.) The eye is moved across the face AB till the image of the pencil-mark, emerging from the face AB is observed clearly. At this stage, the arm  $R_1$  is turned towards the ground face, until the two pins appear in a line with the image of the vertical pencil-mark, by adjusting the micrometer-screw. The reading ( $\theta_2$ ) on the circular scale is noted. The difference between the readings ( $\theta_1 - \theta_2$ ) gives the angle of emergence ( $e$ ). Similarly, the angle of emergence ( $e$ ) from the other surface AC of the prism is measured, by arranging AC perpendicular to the radial line on the prism-table. The refractive index of the material ( $\mu$ ) of the prism can be obtained from the following relation,

$$\mu = \left[ 1 + \left( \frac{\sin e + \cos A}{\sin A} \right)^2 \right]^{\frac{1}{2}}$$

(vi) *Laws of refraction or  $\mu$  of a glass slab.* The radial line on the prism-table is made coincident with zero on the circular scale, with the help of  $R_1$ . The breadth ( $t$ ) of the slab is measured accurately. The rectangular glass slab

ABCD is arranged on the prism-table as shown in Fig. 2 (f). At this position the radial line is normal to the face AB. The arm  $R_1$  is turned through a known angle ( $i$ ) with the normal and  $R_1$  is fixed. The refracted images of the pins are observed on the other side of the slab. Looking along its length,  $R_2$  is turned until the pins on it lie almost parallel to the refracted images of the pins on  $R_1$ . The micrometer-screw is turned for lateral displacement of incident ray until all the four pins appear in a line to satisfy the second law of refraction (Snell's law). At this stage the arm  $R_2$  exactly coincides with the extension of  $R_1$ , which evidently shows that the angle of incidence and angle of emergence are one and the same. Positions of  $R_1$  and  $R_2$  agree with the first law of refraction. The lateral displacement ( $d$ ) of the incident ray is measured with the help of the micrometer-screw. Using the following relation,

$$\sin r = \sin i - \frac{d}{t \cdot \cos i}$$

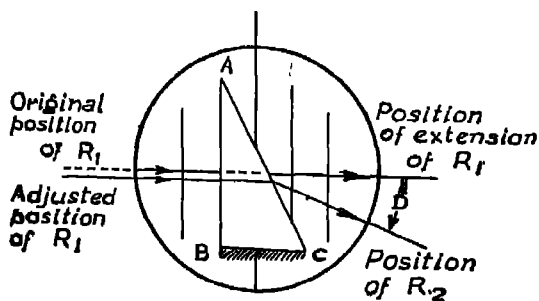


FIG. 2(b)

the angle of refraction ( $r$ ) is calculated. The ratio  $\sin i / \sin r$ , a constant called the refractive index for different angles of incidence and angles of refraction, agrees with the second law of refraction.

### ADVANTAGES

The instrument can be used as a demonstration apparatus, as well as a regular laboratory experiment in junior colleges and schools. The central lines marked on the arms represent the path of light rays, which produce a clear idea in the minds of the students during the course of their study of light. The circular scale by virtue of its larger diameter and fixed pins on the arms, helps in measuring any required angle with accuracy. Since the usual geometrical tracing of the rays is completely avoided, any student can complete his experiment quickly and satisfactorily—reducing the strain on the student considerably. As the cost of the device is estimated to be about one hundred rupees (which is very low when compared with the cost of the spectrometer and its accessories), every school or junior college can afford to use it.

### REFERENCES

The author is thankful to Dr. V. V. G. Sastry, Professor of Physics, Dr. P. Kameswara Rao, Assistant Professor of Physics, and to his colleagues for their encouragement. He is also thankful to Shri M. Suryanarayana Raju, Lecturer in Chemistry, for the help rendered in the preparation of a model of the new design.

The author would welcome comments on this new design from the experts.

## Modern Medicine—A Healer or a Disease ?

KALYANI G. MENON

*School of Life Sciences  
Jawaharlal Nehru University  
New Delhi*

MAN is the only living animal who is conscious of being frail, damaged and headed for total breakdown. The clearer this consciousness, the greater is the need for a symbolic struggle with the inevitable. The well-being of men and women increases proportionately with their ability to assume personal responsibility for pain and their attitude to death. "Culture" and "health", then, are two names for the same thing—the programme by which a social group lives so as to arrive at the optimum state of well-being and which aims at perfecting the ability of its members to cope with the threat from their environment.

Accepting as axiomatic the upward "cultural" evolution of mankind, it has become customary to link this progression with the dramatic changes in the diseases affecting advanced societies over the last century. So many erstwhile mass killers have vanished that over two-thirds of all deaths now are associated with the

diseases of the old age. These changes in health status are attributed to more or better medical care. As a matter of fact, there is no evidence whatsoever of any direct relation between this change and the progress of medicine. The study of the evolution of disease patterns provides evidence that doctors in the last century had affected such patterns to about the same degree as the priests in earlier times. The following data for the death rates by tuberculosis are indicative of this fact.

TABLE

<i>Year</i>	<i>Recorded Cases of Death</i>	<i>Out of</i>
1812	700	10,000
1880	370	10,000
1882	(Koch's isolation of tuberculosis organisms)	
1900	180	10,000
1910	(Opening of the first sanatorium)	
Post-World War II	48	10,000

Similar figures for cholera, typhoid and dysentery show that the peaking and dwindling of disease cycles are outside the medical control—by the time their etiology was understood or their therapy became specific, they had lost much of their relevance. In the case of diphtheria, the data from 1860-1965 show that nearly 90 per cent of the total deaths during this period occurred before the introduction of the antibiotics and widespread immunization. Despite the intensive research, we have no knowledge of the mechanism of these changes. However, the analysis of disease trends show that environment is the primary determinant

of the state of health of any population, which includes food, housing, working conditions, neighbourhood cohesion and cultural mechanisms—all that go to keep the population stable, and play a major role in determining how healthy the people feel and at what age they die. The few modern medical or quasi-medical techniques which have determined small changes in general health are those which become a part of the daily life of the society. This category includes contraceptives, water treatments, antiseptic procedures, smallpox vaccination and a few anti-bacterials and insecticides.

In contrast to the natural environment, and a few non-professional health measures, or a specific medical treatment has never been significantly related to a decrease in the disease burden.

The combination of an impressively complex medical technology and an all-too-believable rhetoric have created a delusion in the mind of the people that modern medicine is highly effective. Informed medical opinion contradicts this assumption.

During the last few decades, a small number of specific treatments have indeed become effective. Those which are widely applicable are usually inexpensive. In contrast, the major proportion of the increased medical expenditure goes into diagnoses and treatments of doubtful effectiveness. The situation can be clarified by considering separately infectious and non-infectious diseases.

Chemotherapy has contributed significantly to the decline of typhoid and venereal diseases. The advent of sulphanilamide and antibiotics resulted in an annual decrease of 8-10 per cent in the deaths from pneumonia, typhoid, malaria and syphilis. The medical impact on these diseases confirmed the belief in "medical progress". However, of late, these diseases

show an upward trend, because of the drug-resistant strains of pathogens.

The effectiveness of medicine in combating non-infectious diseases is highly questionable. Control to an appreciable extent has been obtained only in a few cases—dental caries, for example, has been reduced in some countries by the fluoridation of the water supply (though at a forbidding cost); insuline therapy is successful in treating diabetes (though only in the short run); blood transfusions have lowered death by trauma; early diagnosis of cancer by vaginal smears have raised the response levels to therapy.

Apart from its futility, a proliferating medical technology harms the society in other ways. The pain, disability and dysfunction resulting from the intervention of technical medicine rival the hazards of traffic accidents, work and war—a fact so obvious to doctors themselves that they have coined a name for it—iatrogenic disease (from the Greek—*Iatros* physician and *Genesis*: origin). These are diseases of medical progress, epidemics of modern medicine which would not have come about unless medical treatment had been applied. Figures from the US Department of Health show that one out of every 5 patients admitted to a research hospital acquires an iatrogenic disease, one in 30 being fatal (incidentally, the university hospitals are more pathogenic—in simpler language, more sickening).

All medicines are potentially poisons and their unwanted side-effects have increased with their widespread use. Some drugs are addictive, others mutilating (the thalidomide incidents are still fresh in the public mind), some are mutagenic; some antibiotics induce a super-infection by stronger pathogens, others contribute to the breeding of resistant strains.

Some patients take wrong drugs, others take dangerous combinations of drugs, yet others get counterfeits or contaminated drugs. Unnecessary surgery has become a standard procedure. Professional collousness, negligence and unabashed incompetence are now as much a part of medicine as the pain and injury inflicted by the doctor.

The transformation of the physician from healer to technician, as it has occurred in modern societies, has given an impersonal air to medical malpractice. In a large hospital, lethal blunders are covered up under a respectable scientific blanket; negligence becomes "random human error", callousness is "professional detachment" and incompetence masquerades as "lack of specialized equipment".

The vicious cycle of iatrogenesis has been analysed into *chemical iatrogenesis*, comprising the undesirable side-effects of the patients, technical contact with the medical system; *social iatrogenesis*, resulting from the fostering of sickness by medical practice, which reinforces a morbid society and breeds demand for the patient role; and *structural iatrogenesis* is the manner in which the so-called health sciences act to create a heteronomous, managed maintenance of life on the high levels of sublethal illness. This 3-tiered iatrogenesis has become medically irreversible. The unwanted physiological, psychological and social by-products of medical progress have become

resistant to its remedies and are growing in an escalating spiral, a self-reinforcing system with negative feedback.

Health is synonymous with adaptability—a healthy individual is one who can cope independently with changes in his environment. The primitive societies recognize. The care and maintenance of health in such societies is the duty and prerogative of the individual. The more advanced societies, however, are geared to other goals and health care becomes the business of a medical elite. In such societies, oriented towards unlimited progress, health becomes a cult fostered by the authority. The "enlightened" task of the physician is to administer to a population of unhealthy individuals whose survival depends on his therapeutic services.

Public health is proportional to "the degree to which the means and responsibility for coping with illness are distributed among the general public". The greater the population's potential for autonomous adaptation, the less is the need for a management of adaptation. The more healthy populations are those who, with a minimum of intervention, give birth, live and die, in a clean and balanced environment.

The proliferation of medical technology has resulted in the creation and fostering of a feeble society. The physician's creed has become the artificial maintenance of the levels of health. Is this the miracle of modern medicine ? □

# What Detergents Do

PURAN CHAND

*Department of Education in Science and Mathematics  
NCERT, New Delhi*

THE WORD detergent has been derived from the Latin word *deterge* which means "something which cleanses or purges away". Although detergent has been in use for quite sometime, it has lately become very popular through mass media advertisements. People think of detergents as substances possessing miraculous cleansing property. Detergents include both, the much familiar soaps and the soapless soaps (synthetic detergents).

The use of soap has been known since the early days of the Roman Empire. Pliny the Elder reported in about A.D. 70 the preparation of a soaplike substance from goat's tallow and wood ashes. The earliest developments and improvements of soap were either accidental or the fruit of constant 'trial and error' experimentation. In 1811, Chevreul made the analysis of soap and showed that soap consisted of the alkali salts (sodium or potassium) of fatty acids as obtained by saponification of fats and oils.

The detergent process has been known in some form or the other since the ancient times. It is difficult to give a comprehensive picture of the process because the substances that soil the fabrics are varied in type and a number of properties of detergents are brought into play in removing them. We have detergency in laundering, in the manufacture of textiles, in the preparation of metals for processing and in many housekeeping chores. The basic principles involved in various applications of the detergent action are almost the same. The best approach to understanding the action of synthetic detergents is first to get some idea of the nature of soaps which bear a very close relation with them.

Soap, the oldest detergent, is a sodium salt of a fatty acid of high molecular weight, e.g. stearic acid, oleic acid, lauric acid, etc. Being a very common substance for washing purposes soap has certain inherent disadvantages. Firstly, its cleansing power is greatly reduced in hard water. The calcium or magnesium ions present in the hard water react with soap (sodium stearate) and forms an insoluble scum of calcium or magnesium stearate. Consequently, in hard water, much of the soap is removed from solution in the form of a curd-like precipitate which sticks to the pores of the cloth. Secondly, soap cannot be used in acidic solutions in textile industry because the hydrogen ions of strong acids such as sulphuric acid would replace the sodium ion of the soap. Thus the fatty acids which are quite insoluble in water would be regenerated and form white, curd-like precipitate which would adhere strongly to the textile fabrics during the processing.

### *Synthetic Soapless Detergents*

The industrial and technical developments which took place in the wake of the First World War focussed attention on the disadvantages of soaps and a vigorous search was made to have other detergents which, besides being free from these disadvantages, may be more effective and industrially useful. Synthetic detergents are manufactured from petrochemicals and not from animal and vegetable fats and oils which are needed more and more for food. They are an improvement on—rather than a substitute for—ordinary soaps. They produce an abundant lather. They are better cleansing agents than soaps because of high solubility in water. They also do not form any scum of calcium or magnesium salts in hard water.

There is a great variety of synthetic detergents, but the present study is confined to the two most common types, viz. anionic detergents and nonionic detergents. The anionics ionize in the solution (as soap does) with the long hydrocarbon chain carrying a negative charge. The nonionics do not ionize in solution. Sodium dodecyl benzene sulphonate is an effective low-cost anionic detergent. It is widely used in all types of industrial and household detergent compositions. Generally, all washing powders and washing liquids are made from anionic detergents. The anionics produce more foam than the nonionics. Although foam does not help in washing the clothes, people correlate good detergency with the quantity of foam produced. It has a psychological significance as the cleansing action of a detergent.

The applications and appreciations of the nonionic detergents are increasing. They are particularly useful in liquid soapless detergent products and in some specialized operations such as the cleansing of metal surfaces. They are

useful because they remain active in the presence of acid, alkali, and even high concentration of electrolytes. The nonionic detergents can be used to help disperse the oil slicks at sea.

A detergent has two main functions :

(a) it makes the water 'wetter', and (b) it helps in the removal of dirt.

(a) *Detergents as wetting agents.* Water is not ideal wetting agent. If we put a drop of water onto a piece of fabric, it strives to keep its shape. It does not soak into the fabric because it does not wet it uniformly. When some detergent is added to water, it lowers the surface tension (or interfacial tension) of the water, enabling it to soak into the fabric. Thus, one of the important functions of a detergent is to reduce the surface tension of water, making it 'wetter'.

(b) *Removal of dirt.* Detergency pertains to the removal of dirt or soil from objects or living beings. In the broadest sense, it applies to any process wherein foreign or undesirable elements are removed from a particular material. The latter may be a solid, liquid or gas. Some of the dirt, which strongly adheres to the object, is not removed easily by such simple mechanical means as beating, brushing or wiping with a duster. In such cases, therefore, the detergency is put into action.

### *Detergent Process*

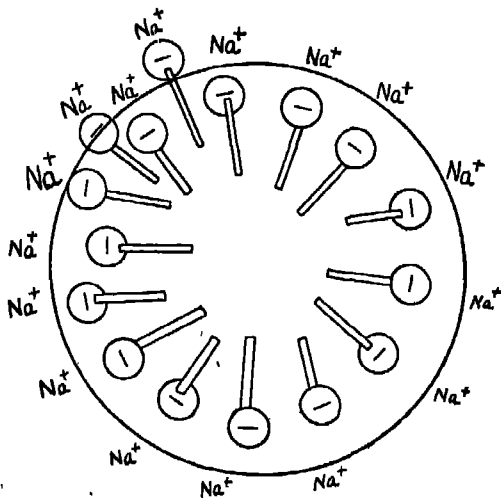
To understand what a detergent actually does in its process of cleansing, let us see how a typical detergent molecule is constructed.

The soap molecule is a paraffin-chain salt ( $C_{17}H_{35}COONa$ ) which consists of two parts: a long hydrocarbon chain ending in a carboxylate anion ( $C_{17}H_{35}COO^-$ ) and a salt-type group ( $Na^+$ ) attached to the end of the chain. Whereas the long hydrocarbon chain is



soluble in water but in soluble in oils. The former is said to be 'hydrophobic' or water-hating and the latter is said to be 'hydrophilic' or water-loving. The hydrophilic salt-group (head) tends to pull the whole molecule into solution, whereas the hydrophobic group (tail) resists this tendency. As a result of this conflicting tendencies, the hydrophilic group is anchored in the water and the hydrophobic group stands as far away from water as possible projecting upwards in the air.

The hydrophobic anions do not concentrate at the surface, but can escape from the water in a different way, e.g. by grouping themselves into spherical colloidal particles which are known as "micelles" containing perhaps fifty to hundred groups. The micelles are formed in such a way that the hydrophobic tails are in the centres of the spheres as they try to avoid the water (Fig.). The surfaces of the micelles are formed by the hydrophilic heads. These micelles act as reservoirs of detergent molecules, ready to come into action as required to remove dirt.



Spherical micelle of sodium dodecyl sulphate

The dirt mostly comprises hydrophobic molecules which do not readily detach themselves from the substrate (textile fabric) without the aid of a detergent. The fundamental reason why detergents are of such great assistance in cleansing is that they have the ability to transform a hydrophobic surface into a hydrophilic surface. The water-repellant tails settle on the dirt particles, the water-loving heads facing towards water for which they have a strong affinity. Thus the dirt layer, which was at first hydrophobic, becomes hydrophilic since its surface is completely coated with the hydrophilic ends of the detergent molecules. When the fabric is agitated, the dirt particles are broken up into extremely fine particles and are easily worked free. They are suspended in the solution by the detergent molecules.

In all types of detergent processes it is commonly seen that larger the solid soil particles more easily they can be removed. For example, soil particles smaller than  $0.1 \mu$  ( $1.0 \times 10^{-5} \text{cm}$ ) cannot be removed from the fabric at all. The mechanical force (agitation) exerted upon the particles in the cleansing process is also of great importance. The greater the size of the particle, the higher the probability that the particle is directly hit during agitation or mechanical treatment of a fabric to be cleaned, as it happens in a washing machine.

Practically, in a cleansing process, detergents are not used as pure components, but are rather used in combination with some additional substances called "builders". A typical detergent for domestic use contains inorganic electrolytes such as carbonate, silicate, sulphate and phosphate of sodium or potassium. Alkaline salts and salts with polyvalent anions increase the interfacial tension and therefore promote the cleansing effect. Condensed phosphates are exceptionally effective for the removal of dirt.

Water-soluble derivative of cellulose, viz. sodium carboxymethyl cellulose, is also highly effective. This is adsorbed on both the dirt and the textile fabric being washed, increasing the negative charges so that the suspended dirt is more strongly repelled from the fabric. Thus, the redeposition of the suspended dirt already removed is inhibited.

The detergents on sale now-a-days also contain small quantities of foam stabilizers, perfumes, colouring matter, and fluorescers. Fluorescer is a special dye that has the property of absorbing some of the invisible ultra-violet light from the sun and re-emitting it as visible light. Thus a fluorescer makes the clothes whiter and brighter.

Like other components of the deterging system such as water, detergent, or builder, temperature is also very important in detergency.

Increase in the temperature of the deterging system enhances the spontaneous separation of soil from fabric by decreasing the strength of the adsorption bonds between the soil and fabric. It also decreases the viscosity of liquid dirt and increases the solubility of the soil. Sometimes, the heat reduces the efficiency of deterging system by decreasing the adsorption capacity of the detergent.

To sum up, water itself is not an ideal wetting agent. A detergent lowers the surface tension of water and thus increases the wetting power of water. This is the first function of a detergent. The second function is the removal and suspension of particulate and greasy dirt. It is important to remember that when a detergent is at work, removing greasy and particulate dirt from fabric, electric repulsion plays an important role and agitation is essential. □

## Science News

---

### MAN AND MARS

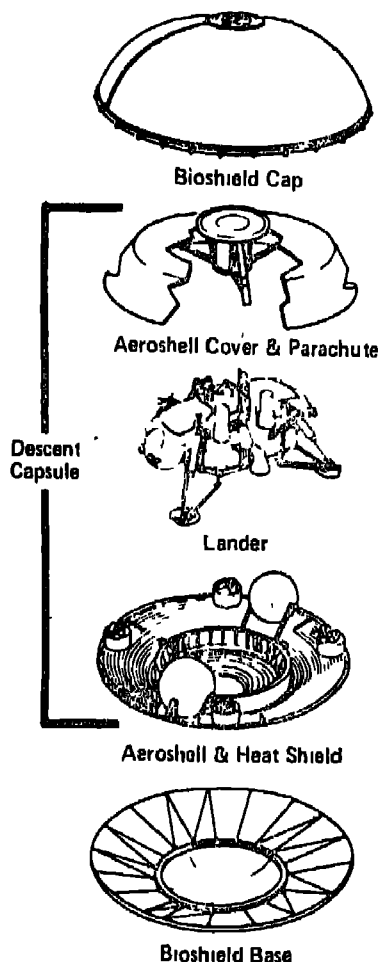
---

#### Viking I lands on Mars

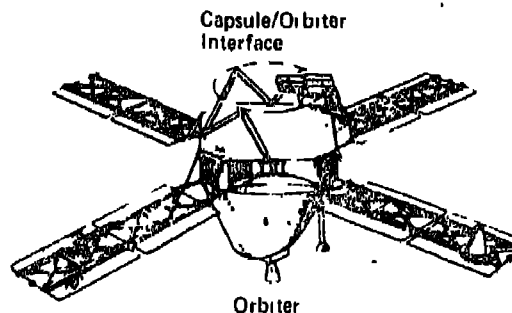
THE SPACE age entered a new phase in July, 1976 when the U.S. landed an automatic scientific laboratory called Viking 1 on Mars, the most likely planet to harbour life. The initial reconnaissance—the survey by fly-bys and first-generation telescopes—is almost complete. The first step of the second phase of exploration—a detailed look at other planets—has started with the landing of Viking 1 on Mars in July and September.

Since the dawn of the space age, the United States has launched hundreds of spacecraft, and conducted six geological expeditions on Earth's closest neighbour, the Moon, and brought back invaluable information about its evolution and the early history of Earth.

Unmanned U.S. spacecraft have flown past or around the Sun, Mercury, Venus, Mars and Jupiter. Of this solar system, only Saturn, Uranus, Neptune and Pluto remain unexplored but plans are under way to send reconnaissance flights to some of them as well.



#### ORBITER SYSTEM



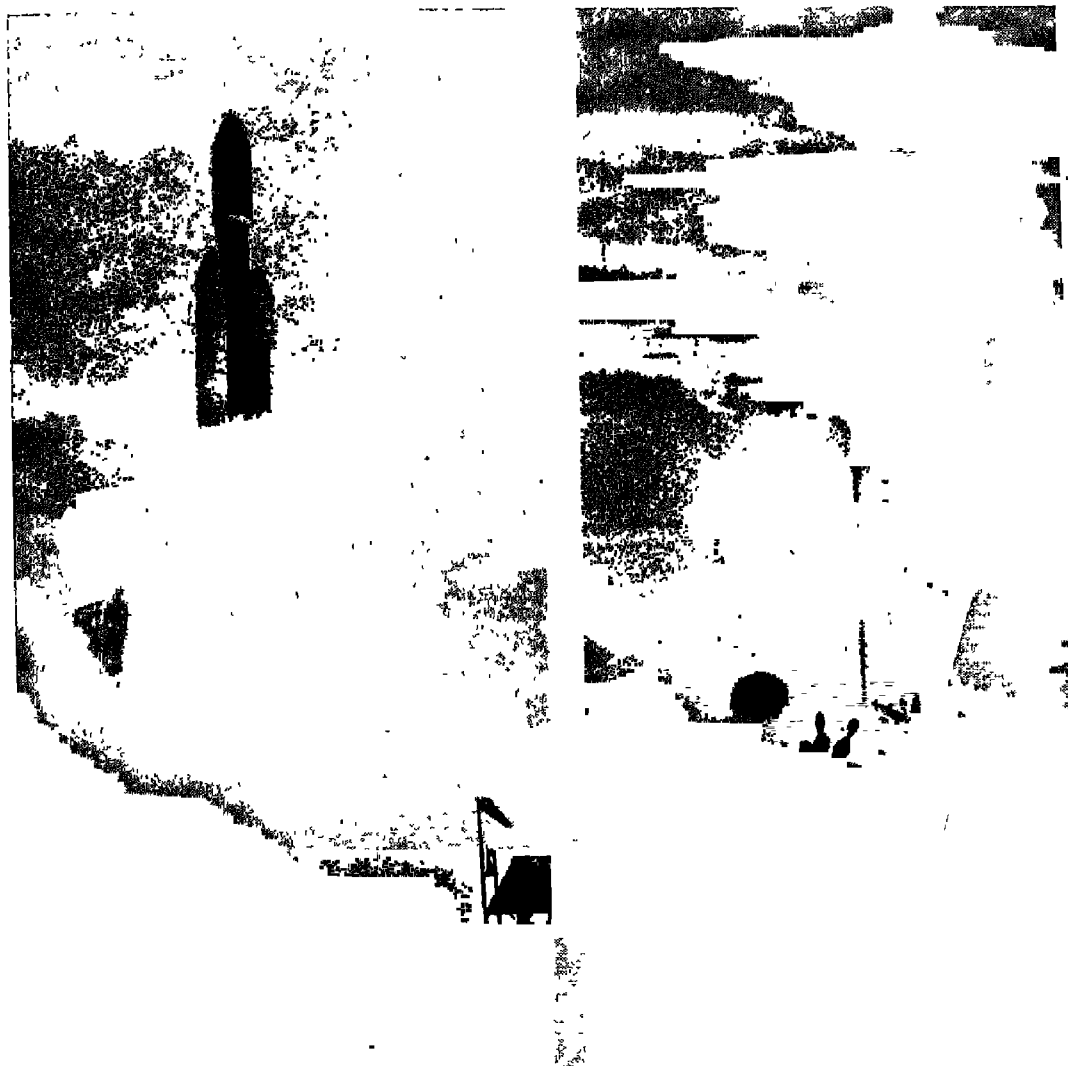


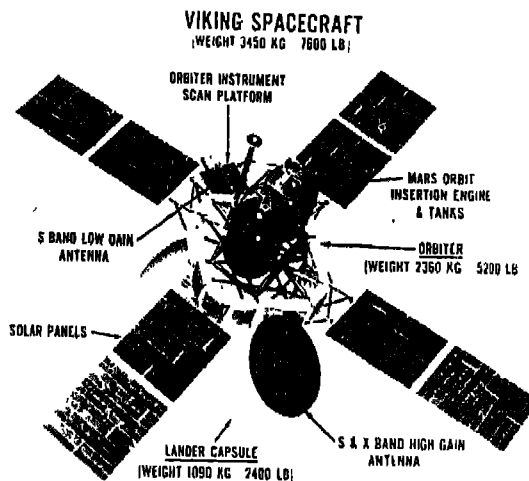
FIG. 1. Two for Mars : America's two Viking spacecrafts begin their 10-month journey to Mars from the Kennedy Space Centre in Florida. Viking I (left) is heading for a July 1976 landing in a region known as Chryse, and Viking II, launched 19 days later, is scheduled to touch down in a Martian low land named Cydonia in early September. Each carries 13 instruments to conduct detailed examination of the planet.

## PLATE II



FIG. 2. This crescent phase picture of Mars was taken by Viking II on August 5, 1976, from a distance of about 400,000 km (250,000 miles). The view is of the morning side. Toward the top of the picture, the four dark spots are the huge volcanoes of the Tharsis region. In the bottom part of the picture, at the tip of the crescent, is a bright circular feature (See the arrow), the large impact basin, Argyre. This basin appears bright because its floor is covered with frost.

FIG. 3. Mars Visitor : A diagram of the Viking spacecraft which is to explore Mars in this year.



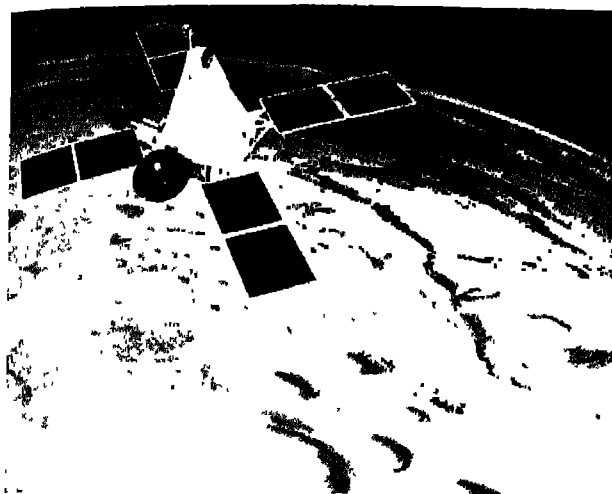


FIG. 4 Dual Probe : A painting showing the unmanned Viking in orbit around Mars, with its life-searching lander and discarded capsule on the surface of the planet. Four solar panels supply electrical power for the orbiter and a white blanket protects its rocket motor from the sun.

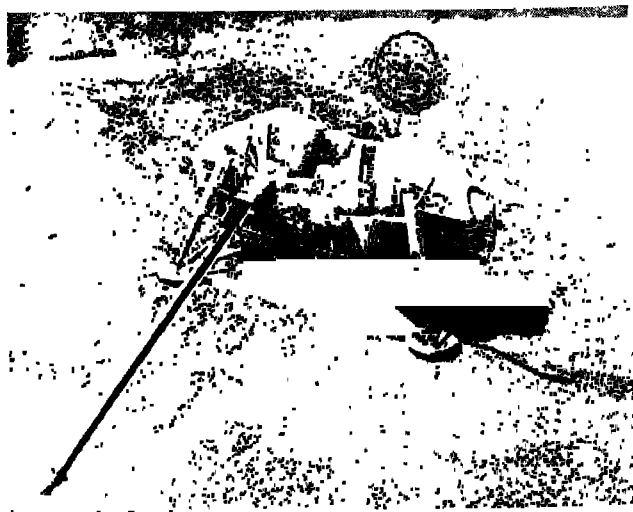


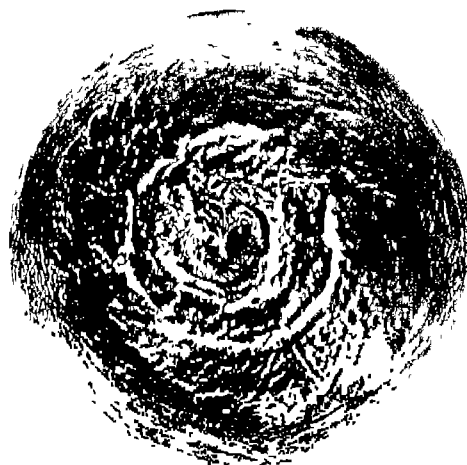
FIG. 5 Plant Probe : This is the Viking lander on the surface of Mars. The three-legged spacecraft is extending its scoop to sample the planet's surface soil.

# PLATE IV



FIG. 6 First colour : This picture showing soil and rocks of varied chemistry was relayed to earth as three black-and-white pictures. When converted into a colour photograph, the first received from Viking I on the Martian surface, it shows deep orange-redish hues in the soil and sky. Project scientists say the soil colour indicates that actions similar to rusting on earth has taken place. The sky colour is attributed to scattering and reflection from redish sediments suspended in the lower atmosphere

FIG. 7. Global Mosaic of Mars : 4 ft. in diameter is made of more than 1500 computer corrected television pictures taken by U.S. Mariner 9 in 1971 and 1972. It is the first photo-glob ever made of any body in the solar system and was prepared by caltech's jet Propulsion laboratory.



—Courtesy : U.S.I.S

The unmanned telescopes and instruments have mapped the Sun and much of the gas, dust and the other stars in our galaxy, the Milky Way, as well as the estimated 100,000 million other galaxies in the universe.

By such probes, the scientists have formulated new theories about how the universe began, how the elements are being created, and how the stars, including our Sun, are born, live and die. We may soon know how the Sun creates, maintains and then releases its enormous energy.

The planets offer a fascinating study. Having evolved differently, each is now at a distinct stage of development, giving a progressive view of how planets form. Mercury appears to have stopped evolving. It is more primitive, less altered, than Mars, and Mars less changed than Earth. The scientists use the planets to look back in time—to observe processes that may have occurred in Earth's early history, but have since been obliterated by evolution. The physical appearance of Mars, for instance, may be what Earth looked like millions of years ago.

The planets also allow the scientists to look forward in time. The atmosphere of Venus with its carbon dioxide and traces of chlorine has already provided vital insights into the current and potential sources of pollution for Earth's atmosphere.

Now with the preliminary reconnaissance of space nearly completed, the second phase—the detailed examination of another planet—is under way. And 1976 will be a watershed year for space science.

In the Viking project, two spacecrafts landed on Mars while two orbiters circled the planet, taking measurements and relaying communications. An automated biological and geological laboratory—the most complex flown in space so far—is there for analysing the soil and atmos-

phere, recording motions in the interior of Mars, monitoring the weather, and sifting the sand for signs of current or past life.

The Vikings will be followed by reconnaissance missions to Jupiter in 1977, Venus in 1978, and Saturn in 1979.

In the 1980s, however, a new tool will be available for the world scientists, which will radically alter the nature and cost of space research. Called the Space Shuttle, this reusable vehicle will be launched like a rocket, land like an airplane, be refurbished and used again. Its power will carry much larger payloads into space, enabling the scientists to perform experiments not possible before.

Compared to other planets, Mars is fairly well known here on Earth. The U.S. Mariner spacecraft have been flying past it since the 1960s, photographing the clouds and landscape and collecting data on Mars' atmosphere.

### *What Mariner 9 told us earlier*

Mariner 9, in 1971, suggested that Mars is something between the inhabited planet of science fiction writers and the geologically and biologically dead planet indicated by earlier fly-bys.

Mariner 9 showed Mars to be pear-shaped. Its surface topography—with one continent and surrounding lowlands—looks as Earth might have appeared 200 million years ago. The processes that caused Earth's upper sections (the mantle and crust) to break into plates that move in relation to each other, may not yet have begun on Mars but there are indications of some crustal activity—the canyons and faults. Perhaps, as geologist Don Anderson of the California Institute of Technology speculates, Mars is just beginning to come alive tectonically.



Mariner 9's greatest discovery was the huge volcanoes on Mars, larger than any in the solar system. The biggest, Olympus Mons, rises 27 kilometres and dwarfs the largest volcanic pile on Earth, the 10-kilometre Mauna Loa in Hawaii. Olympus has a diameter of 500 to 600 kilometres and has had several periods of eruption in the past.

There are other relics of an active Mars: huge fault zones and canyons and puzzling features that look like dry river-beds. Since the surface pressure on Mars today is less than one per cent of Earth's—too low to allow liquid water to remain long on the surface—evidence of a watery environment on a currently dry planet is one of the most interesting aspects of the "new" Mars study.

While there are no streams as such, the scientists believe there is plenty of water on Mars today. Much of the water is probably frozen, mixed with the dust and carbon dioxide ice at the poles, and the rest is probably in the form of 'permafrost' beneath the surface in other areas.

Mariner 9 recorded hydrogen escaping the planet—in an amount that indicates thousands of gallons of water evaporating a day.

The physicist Crofton B. Farmer of the Jet Propulsion Laboratory theorizes that most of the white clouds on Mars are water ice clouds. When the Sun comes up, the frost beneath the surface could melt and turn temporarily into water before evaporating. The existence of even temporary liquid water has important biological implications, since even micro-organisms need some water.

"There is no question water is there," says atmospheric physicist Charles A. Barth of the University of Colorado. "The question is how much?" Viking 2 landing in the high water

area may provide the answer.

Another of Mars' intriguing features are the two polar caps which reflect seasonal changes during the Martian year (the equivalent of two Earth years). The caps grow in the winter in one hemisphere as carbon dioxide and water vapour condense out of the cooling atmosphere, and evaporate in summer.

The Martian atmosphere today is 100 times thinner than Earth's, composed of mainly carbon dioxide, some carbon monoxide, water vapour and perhaps a little oxygen. There are indications that argon—a gas produced by the decay of radioactive potassium—is also present on Mars. Nitrogen, the product of living things on Earth, has yet to be observed.

Since the atmosphere reflects what is occurring on a planet's surface, this composition does not bode well for life. In addition, the atmosphere provides little protection (such as Earth's ozone layer) from harmful solar ultraviolet radiation. Nevertheless, the biologists think micro-organisms could possibly protect themselves by burrowing beneath the soil.

Harold Masursky of the U.S. Geological Survey concludes that "Mars appears to have been a dynamic planet where meteorite impacts, volcanism, fluvial (water) processes, tectonic activity (crustal movements), wind erosion and deposition have all played important roles."

There is some detectable activity today: seasonal clouds and winds, sometimes of hurricane force, and the yearly growth and recession of the polar caps.

Is Mars' interior still active today or has its internal heat engine shut down? Is there a recurring cycle of heavy moisture? Could life be sustained on Mars? These questions are among many that may be answered by the Viking explorers this year.

Centaur Burn  
Parking Orbit,  
2nd Burn

Bioshield Cap  
Jettison

Space Flight  
305-360 days

Mars Orbit  
Insertion

Orbiter

Lander  
Capsule  
Separation

Deorbit

Entry  
800,000 ft

Parachute  
Deployment  
20,000 ft

Aeroshell  
Jettison

Terminal  
Descent  
4000 ft

Entry to Landing  
5-10 minutes

Stage 2  
Separation

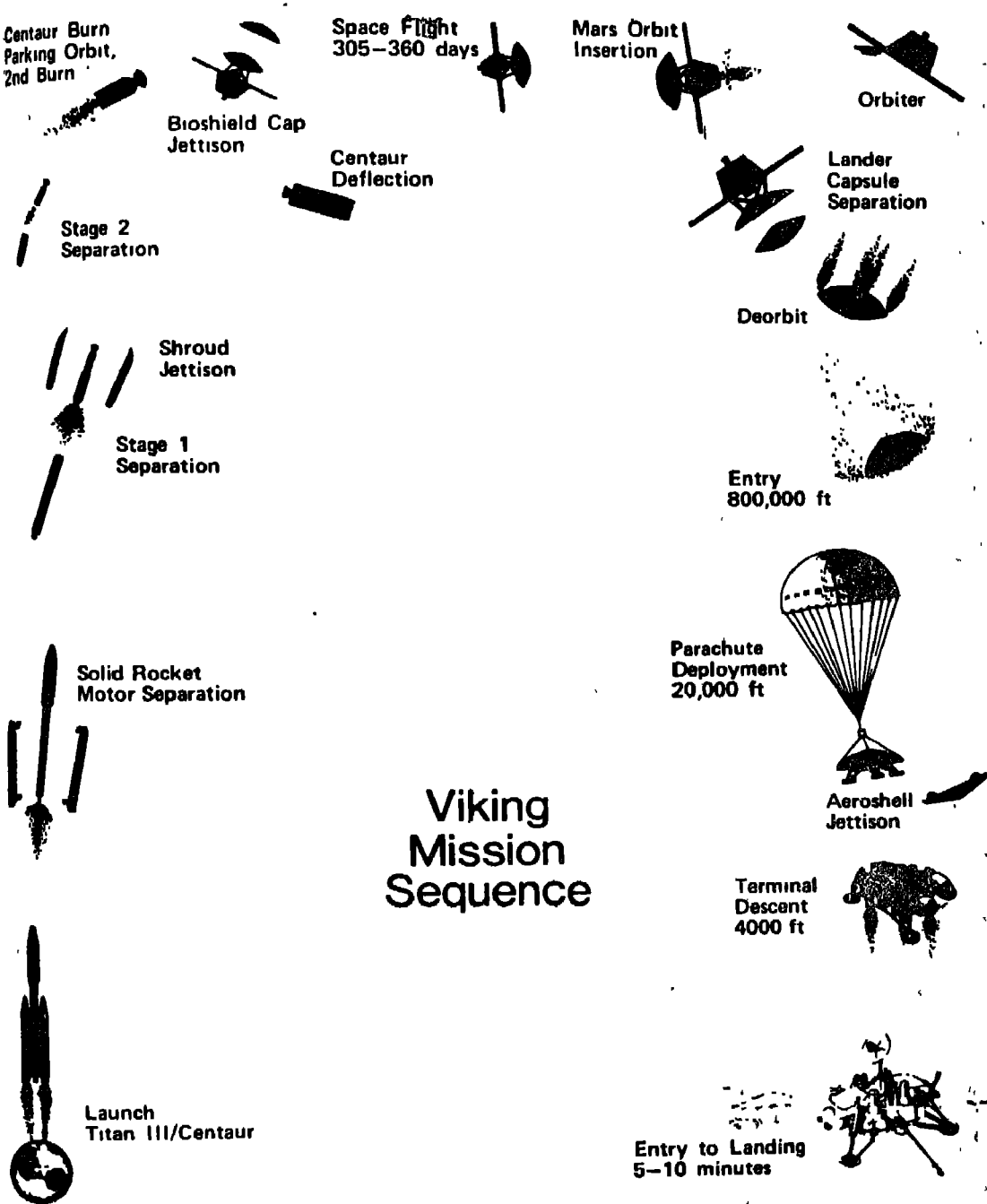
Stage 1  
Separation

Shroud  
Jettison

Solid Rocket  
Motor Separation

Launch  
Titan III/Centaur

# Viking Mission Sequence



### *Search for life on Mars*

The tests on the Martian soil now "cooking" away inside the tiny biology laboratories on board the Viking 1 craft are only the beginning of a lengthy series of analyses to try to detect whether life exists on Mars.

Each of the three biology experiments bubbling inside the lander is designed to go through sequences lasting up to 20 days. And some of the sequences may be repeated up to four times. So it may be weeks or months before any definite conclusions can be drawn.

And that's just for Viking 1. Viking 2, an identical spacecraft, is scheduled to land at another site on Mars this month. If successful, it will start its biology sequences on Sept. 13. So the biologists are well settled in here at Pasadena, site of the Jet Propulsion Laboratory, from where Viking is controlled.

None of the Viking scientists expected the life-detection task would be easy. Even on earth, where tiny forms of life exist virtually everywhere in the soil, detecting its presence can often be a difficult scientific job.

But to try to detect life on a planet 215 million miles from earth, using miniature, remote-controlled instruments that had to survive a flight across the solar system and a landing on a cold planetary surface, is an incredibly more complex task. Especially when the planet is one never before landed upon successfully and the instruments had to be designed years before, when certain key information about chemical conditions on the planet were unknown.

It was not until Viking 1 landed on Mars on July 20, for instance, that we learned that its atmosphere does in fact contain nitrogen. Four-fifths of the air we breathe on earth is nitrogen. Nitrogen is one of the handful of

elements essential to life as we know it. The discovery that the Martian atmosphere contains 3 per cent nitrogen has encouraged the Viking programme biologists about the chances of finding some form of life on Mars. But the fact that they could not depend on its presence until the Viking lander itself radioed back the word shows how tricky the planning of Viking's biology investigations has been.

The biology instrument inside Viking is an ingeniously designed device, a marvel of miniaturization. In addition to a sample-delivery system (which functions much like the cars of a tiny electric train), it contains incubation cells, four different gas supplies, two different nutrients, two monitors of radioactive carbon, a heat-conduction detector, a gas-analysis system, 43 heaters, four coolers, 39 tiny valves, a lamp that simulates sunlight, 22,000 transistors, and 18,000 other electronic parts. It can do the task of instruments that fill more than a room in a university laboratory on earth. All this compacted into a size so small that a person could easily carry it under one arm.

But now that the biology lab. is perking away on the Martian surface, it is not its electronic and mechanical design but what it is doing to detect life that is of prime interest.

How can forms of life too small to be seen be detected by an instrument on another planet? Viking has no microscope. (Few scientists expected Mars to have life forms large enough to see with the Viking cameras, and the photographs show none around this landing site.) The answer is to look for signs that something in the soil is either consuming or giving off substances that we associate with life processes of living organisms (eating, breathing, converting food to energy).

Throughout the 1960s many studies of possible ways to detect life were conducted, and

in late 1969 a panel of biologists recommended that no single life-detection experiment was adequate to take full advantage of such a unique opportunity as a landing on Mars. It recommended that four different life-detection experiments be carried aboard the first U.S. spacecraft to land on Mars. One of the four had to be abandoned in 1973 due to cost, time and engineering restraints on the total package. The three remaining are those working on the Martian surface now.

Each of the three biology experiments is based on different, and sometimes conflicting, assumptions about the possible nature of Martian microorganisms.

The first experiment is searching for signs of metabolic activity in Martian soil samples. Metabolism is the process by which animals on earth—large and small—live. An example of metabolic activity on earth is the process by which humans take up food and oxygen to produce energy (heat) and exhale carbon dioxide and water vapour. Microorganisms metabolize in many different ways, but metabolism almost always includes production and consumption of gases.

The experiment is based on a variety of assumptions. One is that biochemical reactions are carried on in some fluid (on earth it is water). Another is that Martian organisms take in compounds from their environment and produce gas. A third assumption is that the compounds include relatively simple carbon molecules. A fourth is that simple organic (carbon) compounds are present on Mars.

#### *Remote controlled experiments*

This first experiment, called the labeled-release experiment, is moistening any little

Martian organisms in the soil sample with a weak broth of what we hope they consider tasty organic nutrients. Among them are lactate (a salt of a liquid found in sour milk), clycine (the simplest of the amino acids, from which all proteins are built), and glycine (another simple amino acid).

Each of these compounds contains either one, two or three carbon atoms. For the Viking experiment, the regular kind of carbon atom has been replaced by another kind, called Carbon 14, which is radioactive. Whatever happens to these radioactive atoms, they can be traced with a geiger counter, like a detective following an electronically "bugged" automobile.

The hope is that if any Martian organism that functions by metabolism "eats" the nutrient, the gases the organism, then releases—whether carbon dioxide, carbon monoxide or methane, which also contains carbon—will now have hooked on to them the radioactively "labeled" carbon atoms and thus be detectable.

If microorganisms are present and their colony is thriving on the nutrient, the radioactive counts should go up steadily as the organisms multiply. The incubation takes place for 10 days. On the 9th day another squirt of food is issued.

If signs of possible life are found, the chamber can be purged and a "control" experiment performed on a soil sample that has been sterilized. If radioactive gases were again monitored under these conditions, that would be a sign that some process other than life was responsible for them. But if no gases emanate from the sterilized soil, that would be an indication that the previous emissions were due to life.

The second experiment, called the gas-exchange experiment, also looks for signs of

metabolism. It differs from the first and third experiments by requiring no assumptions that Martian biochemistry is based on the carbon atom and by using no radioactive labels. Like the first experiment, it also offers the Martian organisms "food" and then measures any gases they give off after consuming it. But the gases do not have to contain carbon. Hydrogen, nitrogen, oxygen, methane and carbon dioxide are the gases of biological interest, plus others more exotic. And this time the food is not a thin broth but a full, rich concentrated batch of nutrient-thick, vitamin-laden goodies. Some have called it "chicken soup." It contains 59 compounds, including 18 amino acids and vitamins like riboflavin, thiamine and vitamic C.

In this experiment, options are built in to proceed in various directions depending on what happens. After 19 days, fresh nutrient and fresh atmosphere can be added to the original soil sample. Or the original substances and conditions can simply be extended for 19 days. Or, if life processes are suspected, the soil sample can be sterilized and be incubated with fresh food, as a control.

If the first experiment is a test for animal-like life, the third experiment is a test for plant-like life. It uses no nutrients. But it offers the soil sample a small amount of radioactively labeled carbon dioxide and carbon monoxide in the presence of artificial sunlight.

On earth, plants take carbon dioxide and with the help of sunlight and chlorophyll convert it to energy (sugar). This reaction, called photosynthesis, is used by all green plants on earth, and if there are any photosynthetic organisms in the Mars soil sample, this experiment should find them.

Incubation proceeds for five days. After that the soil sample is "fried," or pyrolyzed, at 625° C. Any radioactive carbon that has been assimilated into any organisms would then be given off and be counted by a detector.

A radioactive peak at this time would constitute presumptive evidence for biological activity.

Two variations of the same experiment are also possible. One adds water vapour to the previous ingredients. The other turns off the xenon lamp that simulates sunlight to allow the experiment to proceed in darkness.

These, then, are the three experiments on which human hopes rest for determining whether life exists on Mars. They are considered at least "moderately sophisticated." They are not perfect. But Viking scientists are reasonably confident that if life exists on Mars and if it is present in the soil sample, these instruments will eventually detect it.

Such a discovery would have the most profound consequences, not only for the science of biology but also for the way we view ourselves. It would be one of the great discoveries in the history of science. The biologists would at least have more than one example to consider in framing ideas of the origin and evolution of life. The philosophers would have to ponder the human impact of the knowledge that earth is not the solar system's only abode for life.

A negative result from even both Vikings will not prove the absence of life on Mars. A series of future missions would have to confirm that.

Clearly, the coming days, weeks and months will be an exciting time while we await the word from Mars.

*How does Mars look?*

Mars has blue skies, red soil, rocks that are greyish-green and black and an atmosphere that once could have been very similar to earth's today.

These are the conclusions by scientists here at the Jet Propulsion Laboratory as the first Viking surface data came back to earth.

"Mars somehow looks much more friendly than the Moon," said Dr. Thomas Mutch of Brown University upon seeing the first colour pictures of the surface.

"You see these colours in the Painted Desert," he added. (The Painted Desert is in Arizona in the southwestern part of the United States.)

The atmosphere of Mars, measured as the Viking made its way to the surface, has about two per cent argon and three per cent nitrogen, compared with earth's one per cent argon and 78 per cent nitrogen. "But," said Dr. Michael McElroy of Harvard University, "That amount of nitrogen is enough to support microbial life on Mars today—if at times in the past when liquid water was abundant at the surface—life got started." The major constituent of the atmosphere is carbon dioxide, although there is some oxygen.

Mars' skies are blue because of the dust in the atmosphere that scatters sunlight—the same mechanism that produces blue skies in earth's much more dense atmosphere.

The red soil is produced by oxidation of the surface material—like rust on earth. "It can be produced by weathering," said Dr. Mutch. The weathering could have resulted from a reaction with surface water and oxygen in the atmosphere.

The atmospheric measurements verify that

Mars probably had an atmosphere or nitrogen like that of earth's in its early history. The atmosphere was also probably more dense, allowing the surface water to remain in that kind of environment. Mars would then have had everything needed to start life: energy (from the Sun), water, nitrogen, carbon and phosphorus.

According to a theory developed by Dr. McElroy and supported now by the first data from Mars, the early nitrogen atmosphere escaped earth, which is larger with higher gravity, held on to its atmosphere.

But argon—which is heavier than nitrogen and oxygen—did not escape, and it is the amount of that inert gas in the atmosphere that gives scientists a means of measuring what has escaped.

Nevertheless, even two per cent argon—twice the earth's amount—is a large amount. It says that Mars, like earth, had a very active volcanic period during its first one billion years when a great deal of gas in the interior was ejected into the atmosphere.

The amount of oxygen and hydrogen that has escaped Mars since would form a three-meter thick layer of ice all over the planet, says Dr. McElroy. The redened surface seems to support the theory that large amounts of oxygen and water have interacted with the surface.

The scientists agree that while Mars has lost much of its water, it still has plenty, in frozen form.

Mars is much colder than earth. The average surface temperatures are now below the freezing point of water, although the landing site of Viking-1 probably gets warm enough during the day to melt that ice.

The geologists now think that beneath the dusty surface lie deep layers of frozen water

mixed with dust—permafrost. This source would continually resupply the atmosphere with water.

### *Nitrogen in Earth's atmosphere*

While the amount of nitrogen on Mars is low compared to earth, it is sufficient to support any Martian bugs, Dr. McElroy thinks.

"Most nitrogen in earth's atmosphere is wasted," says Dr. McElroy.

The atmosphere's nitrogen mainly occurs in a form useless to plants and animals. The two nitrogen atoms must be broken apart—or "fixed"—by legumes or bacteria before they can be incorporated into the tissue of plants and animals.

"The Martian bugs would have to be pretty smart to fix nitrogen for themselves," says Dr. McElroy.

On the other hand, they may not have to. According to Dr. McElroy's model, the Martian atmosphere could do the "fixing" for the bugs.

Sunlight hitting the upper atmosphere could break the nitrogen atoms apart to form nitric oxide (NO) that could "rain down" on the surface, supplying as much as one million tons of "fertilizer" a year to the soil. Earth's living systems fix about 100 million tons of nitrogen per year, in addition to that fixed artificially by fertilizer.

The limiting factor in the possibility of Martian life now seems to be the absence of the liquid water that oxidized the red soil and cut the enormous stream channels seen on the Viking photography.

Viking scientists have thus chosen landing sites in low warm regions in the hope of outwitting cold Mars.

The theory is, that while most of the time the water is frozen, during the day the sun melts the surface ice to water, and the dust protects the water from immediately evaporating. Any Martian bugs might have sufficient water to sustain life.

The scientists should know much more about these processes in coming days. The weather station at the Viking-1 Chryse site will indicate whether or not ice does turn to temporary water and the cameras will be able to photograph the rising ground fog.

Of course, the biology experiments will supply vital answers to these questions.

While the first results may not be definitive. The scientists will then know more about Martian life, or the lack of it, than they do now. But the atmospheric results have raised hopes.

### **Scientists try to duplicate Martian soil**

THE MARTIAN soil has turned out to be unlike any soil studied from the earth or moon, and questions about its unusual characteristics have set in motion a series of tests in the U. S. laboratories this week designed to duplicate it here on earth. The scientists hope the tests will show why the soil responded the way it did to two of Viking's biology tests.

The Martian soil is very dry (water there is frozen). Yet when the Viking sampler scoop dug trenches on the surface, the soil behaved much like wet beach sand—cohesive—with straight trench walls. The soil is cold, with temperatures at the site ranging from  $-80^{\circ}\text{C}$  to  $-29^{\circ}\text{C}$ .

The soil is exposed to more ultraviolet light than soil on earth. Earth's ozone layer shields

most of this kind of sunlight from the surface. Mars atmosphere has some ozone, but not enough to block most of this radiation.

In addition, the atmosphere is also exposed to large amounts of ultraviolet light which could cause reactions, producing oxidants such as peroxide. Peroxide and ozone then could rain down on the soil from time to time.

Except the fog, its exposure to ultraviolet light and the Martian atmosphere, the soil—at least at the Viking-1 landing site—is like the soil from the cold, dry valleys of the Antarctic. Samples from these valleys, incubated under Viking-1 biology conditions, often take as long as 200 days before showing signs of life.

But when the cold, dry Martian soil was placed into two of the three Viking biology chambers—the “Labeled Release” and the “Gas Exchange” tests—the soil gave off large amounts of carbon dioxide in one test, and oxygen in another. These responses could be interpreted as signs of microorganisms.

But the magnitude and rapidity of the responses—both gases came off the soil immediately and in large amounts—have led the scientists to believe something else is responsible for the reactions.

That “something else” could be any number of things, including warmer temperatures (the biology labs. are 30° warmer than the surface); water vapour nutrients or soil oxidants.

Before the tests on Mars can be attributed to living organisms, these other possibilities must be eliminated.

To do this, the scientists at the National Aeronautics and Space Administration (NASA) Ames Research Center in California and at Biospherics, Inc., in Maryland, will place a variety of samples into nutrients, water vapour, temperatures, and biology labs. similar to those on Mars.

The soils are of three types. One is a volca-

nic ash, another is a Martian-like red soil with rusty iron (limonite), and a third is soil mixed with elements similar to those detected on Mars (iron, silicon, calcium, aluminium, some sulphur, titanium and small amounts of other elements).

These soils will be divided into numerous samples, ground, put through a sieve, then dried and heated to kill any microorganisms.

Some soil will be irradiated with ultraviolet light; others with ozone, and still others with plasma gas containing ions, electrons, and ions and other gases found in interplanetary space.

Some samples will merely be cooled to Martian conditions, then heated. Others will be subjected merely to water vapour, still others will be exposed just to nutrients.

Since the Martian soil's response to the first two biology experiments could be the result of any one, or all of these factors, each sample will be placed through various mixes.

“We won't settle the question of life on Mars,” said Dr. Donald L. Devicenzi of Ames. “But we hope to isolate any physical or chemical ingredient in the soil that might be mimicking the signs of life.”

Meanwhile, the two biology tests on Mars that yielded the anomalous results continue to incubate and return data.

And more soil is forthcoming from the Martian surface.

## Indian-born engineers work on Mars Viking mission

LANDING a Viking spacecraft on the surface of Mars, 335 million kilometres away, is not easy. It takes precise navigation. Three Indian-born engineers contributed to the vital job of precision navigation of Viking. They



are Dr. Narendra P. Dwivedi, Dr. Navin Jerath and Prem Kumar—members of the Viking Guidance and Navigation Team at the Jet Propulsion Laboratory (JPL) in Pasadena, California, where the Vikings are controlled.

Dr. Dwivedi's team was responsible for the successful manoeuvres that placed both the Viking spacecrafts into orbit around Mars. Dr. Jerath's group, of which Mr. Kumar is a member, keeps constant track of the two Viking orbiters through a new method called "Optical Navigation"—a technique Dr. Jerath helped develop.

All three say the Viking experience has been one of the greatest of their lives.

Dr. Dwivedi's three-year Viking work is almost completed. His chief task was supplying them information for the manoeuvre that placed the two spacecrafts into proper orbit around Mars, while using the least amount of fuel and satisfying the various scientific goals of the missions.

Dr. Jerath's chief job is navigating the Vikings with optical techniques never before used operationally on a space mission. The method was tested, however, on the Mariner 9 spacecraft which orbited Mars in 1971. Dr. Jerath also worked on that mission.

"The technique is an intuitive method," he says. "We use our own eyes to navigate—to walk and move about. On Viking, we use the camera's eyes to see our way through space."

"Radio navigation often results in errors as large as 100 to 300 kilometres," says Dr. Jerath. These errors are largely due to radio interference caused by solar gas that streams through space.

Dr. Jerath just recently received his Ph.D. from the University of California at Los Angeles; his thesis concerned his work—navigating spacecraft with radio and optical

techniques. He received his undergraduate degree in Mechanical Engineering at the Indian Institute of Technology in New Delhi. He was born there in 1916. He received his master's degree from the California Institute of Technology, in Pasadena, and studied also at the Massachusetts Institute of Technology in Boston. While a graduate student, he received the American Institute of Aeronautics and Astronautics "Outstanding Achievement Award."

Dr. Dwivedi received his bachelor's degree in Engineering from the Muzaffarpur Institute of Technology, Muzaffarpur, Bihar, India. He received his master's degree from Texas A. and M. University in College Station, Texas, and his Ph.D. in Electrical Engineering at Auburn University in Alabama. While at Auburn, Dr. Dwivedi became involved in the U.S. space programme. In 1969 he went to work for TRW Systems, an Aerospace firm in Houston, Texas, next to the L.B. Johnson Space Centre. He was a member of the guidance and Control Systems Department for the Apollo landings on the moon.

He won the National Aeronautics and Space Administration's lunar landing award for his work with the Apollo. Dr. Dwivedi then was transferred to the Jet Propulsion Laboratory in Pasadena, in 1971. His first job was analyzing the flight path for the Mariner spacecraft that will be launched in August 1977, to Jupiter and then on to Saturn. The two spacecraft will also pass by 11 of those planets' 23 moons. He was soon drafted, however, for the job of getting the Vikings into Martian orbit.

Prem Kumar is now completing his two years of work at JPL. In September, he will enter the University of Texas at Austin to work on his Ph.D. in Aerospace Engineering.

His goal? "To work on the U.S. space shuttle," he says.

The shuttle is a re-suable vehicle that will take off like a rocket and land like an airplane. On September 17, 1976, the first production model of the shuttle's orbiter will be completed and rolled out of the assembly building. The first unmanned tests of the orbiter will begin in February, 1977.

The first manned tests in May, 1977. If all goes well, the shuttle will start operations in 1979—and Prem Kumar will be there working with the programme.

---

#### MAN FIGHTS DISEASES

---

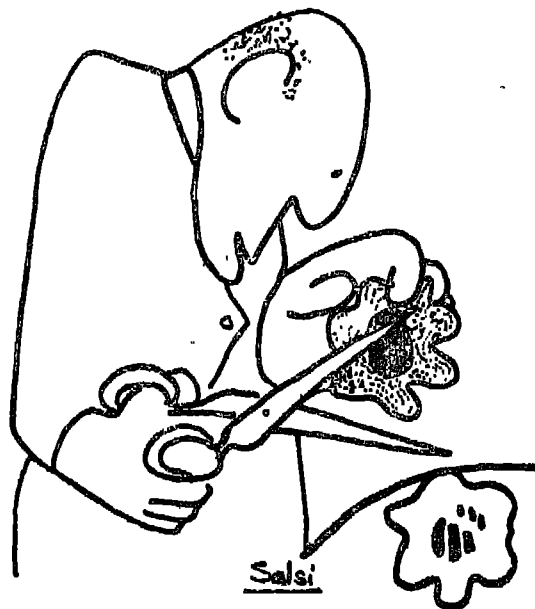
### French scientists seek tailor-made cancer cell killers

UP TILL now, drugs that combat cancer have been found by chance, by random screening thousands upon thousands of chemicals to see what might work. Now, however, a number of scientists around the world including a French research team have begun for the first time to literally engineer new cancer drugs.

Just as a tailor cuts a suit to fit the customer, the French scientists are working to fashion new drugs that are tailor-made to destroy specific kinds of cancer cells.

One such drug, which appears to be effective against a type of human leukemia, has been designed thus far. In early tests on patients, it is doing well.

The research group, headed by Drs. Claude Paoletti and J.B. le Pecq of the Gustave Roussy Institute, a cancer research facility located in the Paris suburb of Villejuif.



#### Random finds

Most of the 30-odd cancer drugs used clinically today were found by random research methods. At the U.S. National Cancer Institute, in Bethesda, several thousands new drugs are tested out each year on large numbers of rodents carrying experimental cancer tumours. The scientists test various natural extracts and their own best hunches in such work.

Molecular biology over the past ten years has made tremendous strides giving the biologists greater opportunity to understand and even manipulate the basic constituents of living cells.

Dr. Paoletti said, "What is the precise target of a particular cancer drug given this new understanding? How does it work at the molecular level? In 90 per cent of the cases, the target seems to be either nucleic acids or

enzymes related to nucleic acid metabolism." In other words, the drugs attack the molecules which work to replicate the cells and thus carry on life. The DNA (desoxyribo-nucleic acid) molecule is the most important of these.

One group of cancer drugs, Dr. Paoletti said, consists of molecules that interact directly with DNA. This group is composed of substances which intercalate between the base pairs of DNA (each DNA molecule is made up of hundreds of thousands, even millions of such pairs, stacked like dishes). Such intercalation prevents the DNA molecule from dividing and so reproducing.

"One thing to keep in mind," Dr. Paoletti said, "is that there are more than 100 different types of cancer cells. About the only thing these diseases have in common is that they kill." Only about 15 per cent of these disease respond to drug therapy, he said. These include the different kinds of leukemia, testicular carcinoma and Hodgkin's Disease.

One reason some cancers respond to drugs and others do not has to do with how rapidly the cancer cells proliferate. The cell doubling time for some solid tumours is slow, taking up to 100 days. For some leukemias, however, it is three to ten days.

It is this factor among others, that renders some cancers susceptible to drugs. As the cells rapidly proliferate, they produce large amounts of DNA. Since cancer drugs tend to interfere with DNA synthesis, they work to stop cell growth.

#### *Finding the right kind of killer*

The problem with such drugs is that they tend to kill all cells, healthy ones as well as the malignant ones. The trick is to find drugs which

kill cells and which also have an affinity for cancer cells. The trick is also to find the dose at which the drug will enter the cancer cells (whose membranes tend to be more permeable to drugs) and not healthy cells.

Dr. Paoletti's team has focussed their research on ellipticines, a class of drugs that is known to interfere directly with DNA synthesis. The drug, which has some 50 varieties, was widely studied in Australia some ten years ago. Like many cancer drugs it is of natural origin, in this case extracted from bushes found on islands in the Indian Ocean. The compound was first synthesized in a laboratory in 1969-70 and at least one variety was found to be effective against human myeloblastic leukemia. This discovery was made by a French team headed by Professor Georges Mathé at Villejuif. Unfortunately, these experiments had to be halted at the time because the substances had a toxic effect producing shock and hypertension in human beings.

During the last few years, Dr. Dat Xuong working in collaboration with Dr. Paoletti has succeeded in synthesizing several new ellipticine derivatives. Two of them have been selected for tests on human beings after extensive experimentation on animals. Formal results will not be available before two to three years, Dr. Paoletti said.

Early indications, however, are encouraging. The drug has extremely high activity at low doses. Ninety-nine per cent of all cancerous cells are killed with a single low dose, Dr. Paoletti said, with no toxicity for normal cells.

#### *Mysteries to be solved*

But a mystery remains. At higher doses the drug is relatively less active. "And we don't

know why this should be so," Dr. Paoletti said.

"Another mystery," he continued, "is to figure out what it is that makes some drugs kill cancer cells while leaving healthy cells relatively untouched. Such affinities are not yet understood. The answers will lie in further molecular biological research."

In the meantime, a new cancer drug, the engineered ellipticine, may soon be added to the arsenal of anti-cancer agents. "What is turning out to be very useful," Dr. Paoletti said, "is to mix these drugs in cocktail fashion. So the more we have, the better."

—Unesco Features

## Urine test for heart patients

THOSE WHO have a "murmering heart," "rheumatic heart" or are prone to some other kind of heart ailment can now keep track of the body's warning before it is too late.

The electro-cardiograph facilities are not always handy, or enzyme and other body tests which need several days to give conclusive results, are not required to monitor a heart-attack for planning some "treatment".

According to two Swedish heart specialists, Dr. Bengt Schersten and Dr. Dag Ursing, "a strip of paper that changes colour is enough to reveal a heart attack."

Under the new cardio-monitoring system developed by the Swedish researchers, the paper strip is dipped into the patient's urine sample. A colour change will immediately indicate if the patient has had a heart attack, however mild it might have been. This would give enough time to plan emergency treatment and intensive care to save the life.

This is how the new test functions: All muscles have a pigment called *myoglobin*. Like *haemoglobin* of the blood, myoglobin carries

oxygen. When there is damage to a muscle, especially of the heart, myoglobin gets separated from the muscle and is carried by the blood to the urine. A chemically treated strip of paper reveals the myoglobin content of urine.

## Psychotherapeutic breathing only under strict medical care

THOSE WHO think that some kind of meditation-oriented breathing exercises are good for a hale and hearty life may be in for a rude shock.

Dr. Wilfried Dogs, Burghof Clinic, Rinteln, West Germany, has warned that psychotherapeutic breathing, generally referred as autogenous training, can be dangerous if not carried out under medical supervision.

Dr. Dogs says "this form of self-hypnosis" can cause neurosis and damage to the heart's rhythm.

In the West the record industry and the so-called "bio-feedback" has been promoting psychotherapeutic breathing. Dr. Dogs has claimed "conclusive evidence" that self-hypnosis aimed at "instant self-improvement" can cause a heart attack.

## A vaccine to treat cancer

THE possibility of producing an almost limitless supply of vaccines to treat diseases varying from allergies to forms of cancer has arisen from research at the Molecular Biology Research Institute of the Medical Research Council at Cambridge.

Dr. Max Perutz, director of the laboratories, is working to discover how the normal cells work and why they break down to become cancerous.

It includes research projects in genetic manipulation to answer a question regarded by some biologists as the most challenging in science. Its solution would carry enormous implications for medicine.

The defensive mechanism, or antibody appears to be generated from a rather limited number of genes present in cells. How one cell can produce a new one that will attack specifically some invader is the question that fascinates the immunologist.

One theory is that the antibodies are produced by somatic mutation, the genes going through changes to create the necessary new material for protecting the body.

The experiments to test that theory have come by creating new cells that are in a process of fusing a special type of cancer cell from the mouth with another type of natural protective cell. The new combined cell has properties that can be used for generating antibodies or for screening for harmful agents.

It is that new type of cell created by fusion that is provoking keen interest.

## **Vaccine against chickenpox**

A SATISFACTORY vaccine against chickenpox has been developed for the first time by the virology department of the School of Tropical Medicine, Calcutta, according to its director Professor A. B. Chowdhury.

He described it as "a real breakthrough". The head of the virology department, Professor J.K. Sarkar worked for more than two years developing a method to isolate the virus alive from a cell and developing the requisite concentration in a fluid.

---

## **MAN AND ENERGY**

---

### **Energy from hot springs**

HOT SPRINGS in the Parvati Valley of Ladakh—and in other mountainous regions—can increasingly be used as an alternative form of energy. According to Mr. Ravi Shanker of the Geological Survey of India, steam coming out of the ground is being used for power generation to refine and extract minerals such as sulphur and borax.

Other uses of geothermal energy very from refrigeration (which has been tried out in Kulu to preserve apples which cannot be moved down when roads are closed) to air-conditioning and heating.

The hot springs at Manali can be used for balneology and therapeutic purposes. When developed these could attract a large number of tourists coming in for therapeutic treatment.

There are 95 hot springs all over India, stretching from Ladakh to Arunachal.

Geothermal energy, though expensive, is indispensable in areas where other forms of energy are difficult to tap.

---

## **WILD LIFE**

---

### **Rehabilitate Gharial**

UNDER a centrally sponsored scheme, efforts are being made in Uttar Pradesh to rehabilitate "gharials" (crocodiles) in some rivers. A centre for this purpose has been opened at Kukulail, near Lucknow, and another is expected to be established at Katarniaghat in Bahraich district.

The basic data about crocodiles habitat and growth are being collected by research scholars for the purpose of an ecological study of gharials. The gharial population in the rivers in Uttar Pradesh has gone down during the past two decades owing to poaching and to the construction of a number of reservoirs and barrages in the rivers.

The Forest Department began a survey in 1975 to study the problem of crocodiles. This was carried out in the Ganga and other rivers. Thirty-six gharial eggs were collected from the Girwa river in April last. Of the 20 hatched babies, 10 were sent to Orissa and the rest transported to the Kukrail centre where eight are surviving.

According to an official spokesman, the crocodile survey has been completed in three more rivers of the State and 454 gharial eggs have been collected during May and June from the Girwa and Chambal rivers. So far 206 eggs hatched and at least 196 more are expected during the year.

Arrangements will be made to rear these babies at the rehabilitation centres in three years. They will be released in the rivers when they become big enough to survive without protection.

There is a proposal to start rehabilitation centres for "mugers" (alligators) on the same pattern as for gharials. Efforts will be made to catch the existing muggers as well as gharials left in the rivers and ponds and breed them in big tanks.

---

## DISCOVERIES AND INVENTIONS

---

### **Building materials from agro-industrial wastes**

THE Central Building Research Institute, Roorkee has recently come out with two processes for converting rice husk into use for building materials, particularly suitable for low cost housing in the rural areas.

The first process in 'the manufacture of a reactive pozzolana based on clay and rice husk'. Rice husk and clay together are mixed with water and made into the shape of balls, dried in the sun and fired in a clamp or in an oval shaped brick kiln. The burnt material is soft and can be easily ground to fineness ranging from 2600 to 9000  $\text{cm}^2/\text{g}$ , giving pozzolana of various reactivity. The pozzolana in suitable combinations with lime or lime-and-sand gives economical mortar and plaster materials.

The second process is 'the manufacture of a hydraulic binder based on rice husk and waste lime'. Rice husk and waste lime sludge generally available from sugar, paper, tannery, acetylene gas and fertiliser industries are mixed in suitable proportions with water and made into the form of balls or cakes, dried in the sun and fired in the sun and fired in the same manner as in the manufacture of pozzolana. The fired product when ground to the fineness of 3000-6000  $\text{cm}^2/\text{g}$  makes a fast setting cementitious material for mortar, plaster, foundation concrete, soil stabilized bricks etc. A 1:3 binder sand mix gives compressive strength of 50  $\text{kg}/\text{cm}^2$ . Several tonnes of these two materials have been made in pilot plant scale trials and used in some experimental construction.

## **Jax and wood wool boards**

MANUFACTURE of Jax board by binding together pre-cut lengths of reed with galvanized wire, and wood wool board with magnesium oxychloride cement as binder has been undertaken in India for sometime past. Commercial exploitation of saw dust to manufacture binderless building boards has also been taken up in the light of research carried out in the country.

Prohibitive cost of synthetic adhesives which are in short supply in India makes the establishment of waste-based panel products industry uneconomic even though sufficient quantities of raw materials are available. Otherwise such wastes as rice straw, wheat straw, corn cob, corn stalk and reeds, etc. could be utilized to produce building boards in a big way as is being done in countries like Sweden, Thailand, Austria and Australia. Similarly, bagasse could be used to produce good quality insulation boards and wall panels.

Laboratory research has clearly established that building boards and panels can be produced from agro-industrial wastes like coconut husk, coir fibre, paddy straw, rice husk, etc. by using cheap inorganic binders like ordinary portland cement. The technology for converting wastes into building boards using inorganic binders is well known and is already used in the production of wood-wool boards in India. Pilot plant trials require to be conducted, however, so that guidance could be provided to entrepreneurs willing to establish small or medium scale industries.

## **Fly-ash as building material**

IN THE super-fine furnace waste from power stations and other coal using industry, now piling up and causing air, water and soil pollution

is proposed to be used as a construction material.

The research laboratories like the Central Building Research Institute and the Structural Engineering Research Centre, both in Roorkee, had established decades ago that fly-ash mixed with clay or cement could be a versatile building material for low-cost housing and other civil engineering purposes. However, its use had not been fully exploited by the construction agencies and the public.

The town and country planners say that use of pure cement should be discouraged in walls and plastering, while fly-ash cement mixes can superbly serve the purpose. The cement saved thus should be used in the drainage systems in the settlements, which are poorly served that way. Moreover, with construction activities picking up momentum, less and less cement should be used where it is not absolutely necessary. Pure cement must be reserved for dams, bridges, heavy-load building structures and even roads. The country is also committed to export larger quantities of cement.

## **A recent genetic find**

AN ADVANCE in understanding the genes which govern individuality in physical appearance and behaviour is near. A research team of the Medical Research Council is putting the last touches to a long investigation in which Dr. Daniella Rhodes, of the Molecular Biology Research Unit, Cambridge, has produced microscopic crystals of the parts of a chromosome.

Until now it has been possible to examine chromosomes only by biological staining methods. Preliminary discussions about the findings have stirred excitement among the

geneticists and molecular biologists. It has not been possible hitherto to see those events by means of staining or any other method.

The Cambridge group is working with Dr. Crick. The work of Dr. Crick and his associates in unravelling how the DNA code worked including the perfection by Dr. Rosalind Franklin (now dead) of some extraordinarily clever analytical methods for examining DNA's composition.

Similarly, the crystals of chromatin (the name for the threads of biochemical materials forming chromosomes) were obtained for analysis by Dr. Rhodes as the result of a superb advance in laboratory method.

## New particle discovered

Physicists from four American institutions have announced the discovery of a new subatomic particle that gives the scientists a much deeper understanding of the basic nature of matter.

Their discovery confirms that there is a quality in nature, which the scientists have named "charm". It is believed to be a physical property of the matter deep within the atom, somewhat like an electrical charge.

The new particle, called *baryon*, was discovered by teams of physicists from Columbia University, Fermi National Acceleration Laboratory (Fermilab), the University of Illinois and the University of Hawaii.

The discovery confirms one of those great leaps of imagination that often mark advances in science. The property of charms was postulated more than a decade ago by Dr. Sheldon L. Glashow of Harvard University and Dr. James D. Bjorken, now at Stanford University.

The discovery adds further support to the idea that the basic constituents of at least half of the atom's particles are things called "quarks". In this view, the "quarks" are the ultimate and basic building blocks, or fundamental particles, of a class of larger particles called *hadrons*.

In the language of physics that has evolved in very recent years, there are "up quarks," "down quarks," "strange quarks", and now, "charmed quarks."

The quark idea—that three quarks constitute the fundamental particles of nature—came several years ago from Dr. Murray Gell Mann of the California Institute of Technology. He took the term from a puzzling line in James Joyce's *Finnegan's Wake*; "Three quarks for Muster Mark!"

The fourth—charmed quark—was suggested by Dr. Sheldon L. Glashow of Columbia headed the four-laboratory team that found *baryon*, particle with a mass of 2.26 million electron volts. The scientists did not see the particle itself, but identified its existence by its decay products—a unique signature of five particles.

The new baryon was found in the debris of high energy collisions.

## New breakthrough in microscope technology

The Bhabha Atomic Research Centre in Trombay has developed a field ion microscope (FIM) incorporating a channel electron multiplier array, says a BARC Press release.

In the field of nuclear technology, for the evaluation of materials, the ion microscope can be considered the ultimate in the sophisticated instruments as it enables viewing of individual



atoms of materials.

The instrument magnified about a million times and is capable of projecting the image of the lattice atoms of the single crystal metal specimens on a phosphor screen.

The Centre has also designed and built a versatile facility for ion implantation of various solid targets.

The semi-conductor industry has enthusiastically adopted this process for the manufacture of integrated circuits.

The incorporation of channel electron multiplier array in the field of ion microscope—the first instrument with this capability in the country—will enhance a closer study of technologically important metals and alloys like iron, steel, aluminium, copper, titanium, zirconium, etc.

The ion microscope is particularly noted for its ability to reveal at the atomic level any damage caused to materials through irradiation by protons or particles.

This aspect is important in nuclear technology as the failure of cladding materials (used in reactors) due to constant and severe irradiation can be simulated and the early onset of failure can be detected due to the atomic scale of observation possible with this instrument.

Similarly, in the metallurgy of alloys, chemistry of catalysis, in corrosion, etc. and thin film physics and technology, the field ion microscope would have an important role to play.

## Breakthrough in cancer research

For the first time in the country preliminary extraction of the "total active alkaloids" of *vinca rosea*, a wild plant, for treating leukaemia

and cancerous diseases has been done in the Regional Research Centre of the Central Indian Medicinal Plants Organization in Bangalore.

The manager of the centre, Mr. N.K.A. Khan said that the extraction of "vinbabin" used for treating cancer was a complicated process and only very few firms in the world had the know-how.

---

## LONG LONG AGO

---

### 12 million years old fossils found

THE Anthropologists of Panjab University claim to have found a large collection of fossil remains of vertebrates from the lower Shivalik deposits, 12 to 16 million years old, near Ramnagar in Jammu and Kashmir.

Professor S R. K. Chopra, Head of the University's anthropology department, said that among the finds were the remains of extinct artiodactyles (even-toed mammals), odd-toed terrissodactyles (giraffe-like animals), carnivores, reptiles and fish.

The anthropologists opened up two small quarries. One of them yielded isolated remains, mostly teeth, of rodents, carnivores, artiodactyles and fish. The other revealed the remains of a large turtle, the dorsal carapace of which measures 90-63 cm.

Floral remains—in the form of leaf impressions—are also said to have been found. The finds will throw new light on the palaeogeographical and palaeoecological conditions during the lower Shivalik times when the area

abounded in some forms of primates, including dryopithecines.

## When it rained glass in Australia

SOME time in the late Pleistocene Age, about 24,000 years ago, it started raining molten glass in central Australia and the shower kept up for a relatively short period, about 10,000 years, and then suddenly stopped.

What was left lying buried in a wide splash across Australia were *tektites*, marble-sized lumps of shiny black glass that now hold a special fascination for tribal aborigines, space physicists, lapidaries, geologists and tourists.

According to the Curator of Natural Sciences in the Museums of the Northern Territory, Mr. Alan Dartnall, "They are all black and glossy. And they are either shaped like dumbbells, teardrops or oblate spheroids—an oblate spheroid being the shape of a button with the rim a little thicker than the centre".

---

### GEOLOGY

---

## The vanishing north India

WILL most of north India, including the whole of U.P. and Bihar, disappear under the Tibetan plateau in the next 50 million years? Such a possibility seems real if the new geological evidence from the Himalayan region is taken seriously. According to many Indian geologists, India is moving northward at the rate of 5 cm a year, pushing up China in the process. In this northward thrust, the Indian 'plate' is

slowly burrowing itself under the Eurasian plate particularly under the Tibetan plateau.

The frequent earthquakes in China and along the Himalayan belt are attributed by the geologists to the collision of the two plates—the Indian and the Eurasian.

Dr. S. K. Mukherjee said his "prediction" was based on a study of the latest data on the Himalayan region.

---

### MAN AND ENVIRONMENT

---

## A dangerous weed: Parthenium

SEVERAL exotic and indigenous weeds have been causing agricultural, ecological and health hazards in the country, from time to time, by colonising in crop lands, waste lands, and urban areas. With nearly two million hectares of land in several States and in Delhi are already under "invasion" by the noxious weed called *Parthenium*. The scientists in various parts of the country are now busy planning a "counter attack" against the weed.

The weed, a native of tropical America and the West Indies, came to India through the PL-480 wheat supplies around 1950, showed its beautiful white flowers in Poona first and spread very fast into other areas in Maharashtra, Karnataka, Tamil Nadu, and Andhra Pradesh, Jammu and Kashmir and Delhi.

*Parthenium hysterophorus* commonly known as "Gajar Gavat" "Pandhari Phule", "Chatak Chandani" or "Carrot Grass", is one of those noxious weeds which belong to the family of *Asteraceae* (Compositae).

It has a very fast rate of multiplication and

**Parthenium**

about 5,000 seeds are produced per plant. They spread through water and air. This noxious weed can grow in all kinds of soil under different climatic conditions and can complete life-cycles in a year. The parthenium seeds do not have dormancy period and remain viable for a long time. The plant grows to a height of 1 to 1.5 meters with a profusely branched root system. It bears numerous white flowers, each having a number of seeds.

Several harmful effects of Parthenium are :

- (a) It causes allergic eczema, and produces Contact Dermatitis when the infected parts especially the face, neck and arms; develop hard crocodile like skin with cracks and sores.
- (b) The weed is also a nuisance for animals; cows infected by it get fever and rashes. Moreover, there is a presumption that the milk gets contaminated by the active principal Parthenium which is toxic.
- (c) It provides a hiding place for snakes and other dangerous animals as well as for mosquitoes and harmful insects.
- (d) The agricultural crops like sorghum, paddy, ground nut, vegetables, cotton, potato, grapes, lady's-finger, soyabean, guava, ragi, etc. get infected by its invasion in agricultural land.

#### *Eradication programme*

In view of the seriousness of this growing problem, the Department of Science and Technology convened a meeting of various scientists

and medical doctors from all over the country. They discussed the magnitude of the problem and the broad framework for drawing an operational programme at the national level involving joint collaborative efforts of various scientists, technologists, managers and farmers of the country to check the fast propagation of this weed and to save the livestock and human population from its dangerous effects. It was mentioned that if a systematic bio-chemical analysis of the weed is undertaken, it might be possible to extract some important chemicals from this so-called useless plant.

A systematic study of ecology and physiology of this weed is absolutely essential and it was decided to undertake :

- (a) a survey of the areas in the country where major concentration and growth of this weed occur,
- (b) systematic ecological and physiological study,
- (c) bio-chemical analysis of the weed,
- (d) bio-medical and pharmacological research on Parthenium and survey of the incidence of the disease in the country, and
- (e) mechanical and biological control measures to be adopted on large scale.

It is very interesting to note that this weed has not posed any serious danger in its native lands like West Indies, Argentina, Mexico and the USA. The only reason to be attributed to this is that in India, in the absence of its natural enemies like pests and pathogens, it has spread fast. □

## Book Review

### *The Lives of a Cell*

Lewis Thomas, Bantam International Edition, 1975,  
pp. 180, \$ 1.25

Wise is the reader who knows that he is not to argue with the author if the latter's views are somewhat partial, the interpretations oversimplified and the style florid. They are the author's very personal. The earlier this realization, the better. And only when you have known this, you relish the wit of the author and the glimpses of our biological cosmos in *The Lives of a Cell*, a lively collection of thirty essays by Lewis Thomas. Lucidity, poetic excitement and a shimmering vision make this small book a worthy cerebration on life and our planet.

Man and nature make a vast panorama. Viewed from a suitable height, the earth is like a single cell, describes the author. And here are the stories of life of a complex cell "with too many working parts lacking visible connections". The stories are obviously too diverse, however, but there is one underlying idea that is constant—the earth is a living cell, I mean, a cell in the biological sense.

Are/were mitochondria and chloroplasts micro-organisms? Were the cells of plants and

animals rented and occupied, in the remote past, by migrant prokaryotes whom we call mitochondria and chloroplasts? Have they maintained themselves and their ways, privately with their own genetic system? Perhaps so, but then these are old questions. Many of us tend to accept this view because it smells like drama; seldom do we arrive straight at this conclusion at the end of a scientific analysis. Inquiries about the evolutionary origins of these cell organelles and their genetic, biosynthetic and metabolic independence reveal a previously unexpected degree of complexity. Biochemical analyses do not always conform with the above speculations. For instance, the DNA in mitochondria is too limited in size to code for all the proteins and enzymes found in these organelles.

We move from mitochondria to man. Schizophrenic persons, we are told, have a special odour to their sweat due to the presence of a particular chemical, methyl hexanoic acid. I wonder, the number of persons emitting this very smell is perhaps very close to the total number of civilized men. But what on earth do they do with such a smell? What do they communicate?

Young women living closely in dormitories undergo synchronized menstrual cycles. Or, the beard grows faster when one is in the company of girls. It is surprisingly common a phenomenon in the living world—an animal influences the behaviour of other animals of the same species through the small molecules of pheromones. This must be interesting to the front-line workers in immuno-chemistry. Somewhere on other worlds, maybe, civilizations communicate by the exchange of chemical

substances that are smelled or tasted.

Now, from signals of smell to those of music. To make a kind of music is as much a characteristic of living forms as our other fundamental functions. The songs of whales are statements about navigation, of sources of food or limits of territory. Leeches tap rhythmically on leaves and engage the attention of other leeches. Toads sing to attract their females and earthworms make faint but regular staccato notes. It is obviously hazardous, however, to try to assign a particular meaning to all the sounds made by various creatures, man included.

A story of signal again, but of a different taste. Suppose we establish contact with a planet circling around the *Tua Ceti*, a relatively nearby sun and suppose we have a galactic neighbour out there, as intelligent or as stupid as we are. "Hellowl, are you there?" from us followed by "Yes, hellow l" from them will take at least two hundred years. By the time we have our party, we may have forgotten what we had in mind. After all, we have to send something which will not fade out from our interest in two hundred years. What would that "something" be would be a hot subject for two hundred years of debate.

On we go enjoying a feast of readings, every one of them—"various words" and 'living language', 'probability and possibility', 'biomathology' and 'planning of science.' 'Iks,' the nomadic hunters of Uganda engage one as much as do the 'computers'. And as one moves from 'natural science' to 'natural man,' one faces that question which makes one feel a bit uncomfortable—whether the world belongs to us or we belong to it!

Can we dream of something totally beyond our direct or indirect experience, say, an animal, a civilization, or a colour? Perhaps we cannot. Mythological "characters", Ganesh and Griffon, Sphinx and Phoenix, Centaur and

Chi-lin—none of them is a son of pure imagination. They are the chimera of parts which are entirely familiar.

The last essay is perhaps the finest of the whole series.

The author finds a unique parallelism between the origin, nature and development of the membranous structure that surrounded the first protocells and those of the blue veil of sky that surrounds our little planet. Seldom do we find an analogy so pregnantly apt, coupled with a description so scientifically perfect. Development of a semipermeable membrane around the 'unit of life' was a unique phenomenon; the previously diffused biological molecules separated themselves from the surroundings. The cell had to be able to trap energy and hold it, store the required amount and release it in measured share. The cell membrane made the first sense out of disorder in biology.

Likewise, when the earth came alive, it began constituting its own membrane, for the general purpose of editing the sun. There was nothing like a sky during the pre-biotic elaboration of peptides and nucleotides in the primeval earth. The story is now familiar—how oxygen molecules gave rise to the ozone layer which filters out many of the sun's rays. And then at a later stage, when the early living forms had already appeared, photosynthetic activities by early plants helped in the accumulation of oxygen in the atmosphere. All this led to the singularly miraculous achievement of the young earth—the sky.

When one looks at the planet, say, from the moon, it shows itself truly as a living cell, surrounded by a bright, blue sky. Beyond that, all is dark, deep and hostile space. The earth is a lonely little "cell". □

UTPAL MALLIK

Department of Education in Science  
and Mathematics, NCERT, New Delhi.

## Scientific Terms

### *Used in This Issue*

**Benthophagic:** Feedings on bottom dwelling organisms.

**Chloroplast:** Green plastids—cell organelle containing green pigment, chlorophyll that help to trap solar energy. It occurs in the green parts of the plants and plays a major role in the preparation of food by photosynthesis.

**Detritophagic:** Feeding on decaying organic matter.

**Enthalpy:** Heat or energy content.

**Entropy:** A quantity introduced in the first place to facilitate the calculations, and to give clear expression to the results of thermodynamics.

**Fin formula:** Number of fin-rays of different fins. It is usually specific for a species and expressed in a set order.

**Lateral line:** Laterally situated in the body of a fish, a series of modified scales, provided with a mucous tube or pore which connects with the lateral line canal.

**Myomere:** Segmental muscles.

**Pheromone:** Chemical substances released in the surrounding by organisms which influence the behaviour of the members of the same species.

**Parallax:** The shift in the apparent position of a body due to a change in position of the observer.

**Snell's law:** It is a law of refraction, which states that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant for any pair of media (named after W. Snell, 1591-1626).

**Thermodynamics:** The study of general laws governing the processes which involve heat changes and the conversion of energy.

□

# School Science

Vol. XIV No. 4  
December 1976

A QUARTERLY JOURNAL OF SCIENCE EDUCATION

---

## CONTENTS

	1	EDITORIAL
<i>J. V. Narlikar</i>	3	Scientific Attitude and Development in Science and Technology (EXCERPTS)
<i>B. Sharan</i>	13	Aryabhata
<i>R. P. Bhatia</i>	17	Werner Heisenberg: A Revolutionary in Physics
	21	Nobel Prizes in Science 1976
<i>B. Ganguly</i>	27	Teacher Training Programme
<i>S P. Kanwal</i>	32	Pollution—A Case Study
<i>B D. Sharma, Tej Sharma</i>	39	The Capture and Care of Snakes
<i>M. A. Chandrasekar</i>	41	Bionics
<i>S. C. Jain</i>	43	Secondary Education in Switzerland
<i>A. Venkatacharlu</i>	47	Magic Squares
	52	SCIENCE NEWS
	64	BOOK REVIEW
	65	SCIENTIFIC TERMS



## TO OUR CONTRIBUTORS

SCHOOL SCIENCE, a quarterly journal, acquaints the teachers and students in schools with the recent developments in science and science methodology. It aims to serve as a forum of exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc. should be neatly typed, double-spaced on uniformly sized paper, and sent to the Editor, *School Science*, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110016. Each article may not normally exceed 10 typed pages.

The articles sent for publication should be exclusive to this journal. Digests of previously published articles modified to suit the scope and purpose of *School Science* will be accepted. In these cases the name of the journal in which the original article appeared must be stated.

Headings should not be underlined.

Selected references to literature should be arranged alphabetically at the end of the article. Each reference should contain the name of the author (with initials), the title of the publication, the name of the publisher, the place of publication, the volume and page numbers.

In the text, the reference should be indicated by the author's name followed by the year of publication enclosed in brackets, e.g. (Passow, 1962). When the author's name occurs in the text, the year of publication alone need be given in brackets, e.g. Passow (1962).

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of postcard size, and should be sent properly packed so as to avoid damage in transit.

□

---

## *E d i t o r i a l*

---

WE DO NOT KNOW how many, if ever, among the great scientists, artists, philosophers or philanthropists have worked for a prize or the prestige of an award. Awards and prizes are recognition by the society of the contributions made by the distinguished ones. Even the Nobel Prize is no exception. This is not to underestimate the value of the Nobel Prize or to belittle the significance of our appreciation. Recognition of a genius is imperative for the perpetuation of civilization and advancement of its frontiers. Appreciation is a stimulus for the pursuit of knowledge and achievements. But it is not the only source of inspiration. Many of the greatest had to struggle all alone with few to cheer them.

Instituted by the will of a lonely person, Alfred Nobel, the famous Swedish inventor of the dynamite, the Nobel Prize is awarded every year to the persons having made the greatest contribution towards human welfare in the preceding year. The award was made for the first time in 1901, from the fabulous fortune left by Nobel for the purpose.

The Nobel Prize is now considered the biggest international recognition. Though judged by only a few represented on committees, academics and institutes located at a small corner of the world, the Nobel Prize is looked upon as universal appreciation of genius. Fortunate are the men who receive such a reward in their lifetime; proud are the countries which hold them. The prize also makes a good piece of work known, understood and appreciated in a much wider circle. The money and the recognition attached to the award has helped many in carrying out further research.

This year, all the Nobel Prizes awarded (physics, chemistry, medicine, literature and economics) have gone to American citizens. Bagging all the Nobel Prizes of the year is a record performance by any nation. The Americans may genuinely feel proud of it, specially the unique honour coming to them as it does on the occasion of the 200th anniversary of their independent nationhood. We pay our warm tribute to all the individual recipients of the awards, which they so eminently deserve.

Glancing through the long list of 75 years of Nobel awards, particularly in sciences, certain trends are discernible in the number of prizes received by various countries. It is striking that during the first 20 years, majority of the prizes went to Germany, England, France and other west European countries. In the next 25 years, the honours were more or less evenly shared by western Europe and the U.S.A. For the last three decades, the Americans have just less than monopolized the awards. The west Europeans and the Soviet Union have,

of course, the minor share. It is also noticeable that the rest of the world—the continents of Asia, Africa, South America and Australia—have had the honour only on rare occasions. India got it last in 1932 (Sir C.V. Raman) and none since independence.

Such a countrywise comparison, of course, is not intended to establish the Nobel Prize as an absolute measure of the scientific researches in a country. Today's science is too complex and articulated an activity to be amenable to such a simple measuring device. The nature, direction and priority of scientific activity are determined by the widely variable needs and resources of the countries. The criteria of evaluation of the awards may not fit in with the direction of research followed in a particular country. Again, the selection of awards also is not always undisputed. Even the distributors do not cherish the illusion that their choice is beyond criticism. This is simply impossible, considering the exacting assignment. But it cannot be denied that the prizes have been awarded to excellent pieces of work, if not the very best ones.

Therefore, a comparative study of the list of recipients certainly gives an outline of the highest scientific achievements of different countries. The outline is not much different from the achievement pattern obtained through other parameters—quantum of input in research, training and development of researchers, the number of working scientists, standard of laboratories and volume of original publications. It becomes evident that the Nobel Prizes have often favoured the developed countries. This is a case more of correlation than of coincidence, because higher scientific research can no more be conceived as an isolated growth, divorced from social development. Science, specially fundamental science, is a consumption as well as investment item which often has no immediate returns. Scientific achievement of a country is invariably related to its techno-industrial ability and the quantum of its financial support to fundamental research.

And, as we have said earlier, scientific pursuits do not originate from the lure of a prize. Prizes come late, crowning the success. Appreciation may not come in the researcher's lifetime, or may be delayed for centuries. Aristotle, Galileo, Copernicus, Newton, Pasteur, Marx, Darwin, Nobel, Mendel, Tolstoy, Ibsen and Gandhi—all memorable names, and their achievement did not wait for the Nobel Prize. The source of inspiration to all scientific endeavours is a passionate desire to know nature and natural forces and move the frontier of knowledge beyond the familiar or the accepted, possession of unshakable faith in the arduous process of cerebration and the ability to work untiringly with a readiness for self-sacrifice. The basic qualities of honesty, dedication, patience, objective vision and original ideas are the only key to success.

Our new national education will be meaningful only if it can kindle in our children a quest for knowledge and make them humane.

In this issue, we have given brief sketches of the lives and scientific contributions of this year's Nobel laureates with the hope that this will illustrate the qualities a scientist must have. □

# Scientific Attitude and Development in Science and Technology

EXCERPTS

JAYANT VISHNU NARLIKAR



PROFESSOR JAYANT VISHNU NARLIKAR struck the headlines of newspapers and became one of the frontliners among the scientists almost overnight, and that too in his mid-twenties, for a new theory of gravitation on which he worked with the famous Cambridge astrophysicist Fred Hoyle.

Narlikar was born in 1938 in Kolhapur. He has had a brilliant career as a student and scientist. He obtained first position and first division in all his school and university examinations. After his graduation from the Banaras Hindu University in 1957, he was awarded the Tata Scholarship for higher studies. Narlikar went to Cambridge University, England, where he passed in mathematics with distinction in 1960. The same university conferred on him Ph.D. in 1963 and Sc.D. in 1975.

As a research scholar under the supervision of the famous British astronomer, Prof. Fred Hoyle, Narlikar distinguished himself and published many papers. He worked on some important problems of astronomy, including gravitational collapse and a new theory of gravitation. He won many prizes and

awards including the Tyson Medal in 1960 and Smith's Prize in 1962. In 1965 he received the civilian award of Padma Bhushan from Dr. Radhakrishnan, President of India.

Dr. Narlikar is a Professor of astrophysics at the Tata Institute of Fundamental Research, Bombay, and is actively pursuing research in many areas of physics and astronomy. He has already published more than 80 papers. He is also a Jawaharlal Nehru Fellow as well as Fellow of many national and international scientific societies.

Prof. Narlikar is a kind and unassuming personality. He is soft-spoken and an effective public speaker. He has delivered many popular lectures on science and scientific attitude. On November 13, 1976, he delivered the Jawaharlal Nehru Memorial Lecture in New Delhi on the **ROLE OF SCIENTIFIC OUTLOOK IN DEVELOPMENT OF SCIENCE AND TECHNOLOGY.**

We feel privileged to publish excerpts from this lecture in this issue of School Science. We are grateful to Prof. Narlikar and the Jawaharlal Nehru Memorial Fund for granting us this privilege.

WRITING to his daughter about the quest of man, from the District Gaol in Dehra Dun on June 10th, 1932, Nehru had this to say :

" . . . . Science gives a doubting and hesitating reply, for it is of the nature of science not to dogmatize, but to experiment and reason and rely on the mind of man. I need hardly tell you that my preferences are all for science and the methods of science. . . ."

Thoughts like these were to prove important for the growth of the newborn nation in 1947. They continue to be important to us today. . . .

#### THE SCIENTIFIC APPROACH

School children learning science are told that a scientific investigation consists of three steps: the experiment (*E*), the observations (*O*) and the deduction (*D*). This particular pattern of investigation has emerged after centuries of practice of science; and the scientific outlook that I want to talk about lies somewhere at the bottom of it. . . . Its origin lies in the questions "What?", "How?" and "Why?" that man put to himself and tried to answer. Each answer gave rise to many more questions. While a correct answer closed one particular subject, it at the same time opened up several new ones. And this proliferation of questions and answers has led to the vast and expanding field of science that we see today. . . .

Let us see how the E—O—D process operates in science. As mentioned above, its beginning lies in some question about Nature, let us say, about a certain phenomenon seen to occur in our physical world. The experimental part now comes in. The experiment is set up to observe the phenomenon in several different ways. The experimenter can, in many cases,

alter the various operating conditions, to enable him to study the outcome in as many situations as possible. Another object of such experimentation is to eliminate the human element as far as possible and make the results objective.

The next step of observation is not as straightforward as it may sound. The result of the experiment may be qualitative or quantitative. In the latter case the scientist ends up with a set of figures. Before any deductions can be made, it is often necessary to detect a pattern in the observed results, and this is where the so-called signal and noise come in. Here 'signal' represents the pattern which one is looking for against a background of a maze of data, called the 'noise'. The analogy of a specific sound signal against a noisy background is quite clear. How does one extract the signal? The human eye of an experienced experimenter is very often able to detect this. There are cases, however, where this is not possible and help must be sought from the statistical methods of data analysis. Recourse to statistical methods is in any case desirable to ensure objectivity. Unfortunately, there are situations where even statistical methods are not able to give unambiguous answers. The scientist must then . . . design . . . new and better experiments.

The last . . . step in this process is that of deductions . . . The scientist is . . . not satisfied with drawing the conclusion for the one experiment he has just performed. He is interested in making predictions for other situations not covered by his experiment . . . The purpose of this exercise is to prompt future scientific experiments to be designed to test these predictions. His own experiment may also have been done to test the prediction of a previous scientific theory.

This interplay between theory and observations is what keeps science going. Without scientific theories to guide him, the experimenter will not know exactly what to observe. Indeed, the modern scientist knows that no scientific theory . . . will be entirely correct. Sooner or later some new experiment will be designed which will disprove some crucial prediction of the theory. But eventually . . . a new, enriched order . . . emerges.

Thus the disproof of a well established scientific theory is regarded as a very exciting event by the scientist . . . It was in this connection that Sir Hermann Bondi, the well-known astronomer, remarked:

The essential thing in science is for the scientist to think up a theory. . . . It always requires human imagination, and indeed in science we pay the highest respect to creativity, to originality. It is, of course, clear that since every theory must live dangerously the casualty rate is pretty high. So we do not honour scientists for being right. It is never given to anybody to be always right. We honour scientists for being original . . . for having started a whole line of work. Science is the most human of endeavours because it depends on co-operation, it depends on people testing each other's work and it depends on people taking notice of each other.

—from *Cosmology Now*, Ed. L. John,  
1973, B. B. C. publications

It is against this background that one must see what is meant by the scientific outlook. . . . Although it arose out of the development of science it has proved useful to the conduct of human affairs in a wider context. Nor is the

scientific outlook necessarily confined to those who practise science. An uneducated [person] may be endowed with it whereas a professional scientist may be devoid of it! We will now look at some examples of how this outlook influenced the growth of science.

### THE MOTION OF PLANETS

For time immemorial man has looked at the clear night sky and wondered what the heavenly objects were supposed to be. He must have compared and contrasted their appearance with that of the Sun during the day. From where does the Sun appear in the East and where does it go in the West?

Now, there is a tendency in the human mind to ascribe strange natural phenomena to supernatural causes. This tendency runs counter to the scientific approach which is born out of curiosity and thrives on a critical assessment. We see an excellent example of the two tendencies in man's approach to the motion of heavenly bodies. Man ascribed supernatural powers to the Sun, the Moon and the stars. . . . Those with the irregular motions were singled out as having greater power because their irregularity implied that they could move across the sky 'at will'. These are none other than the planets of our Solar System. From this to argue that these 'powerful planets' control human destiny. We could understand and sympathize with this view, shared by most primitive cultures, more than two thousand years ago. But today, when the scientific approach has provided the answers, the situation should be entirely different.

How the scientific outlook prevailed and led to the solution of the mystery is an interesting story. Among the primitive cultures

records were kept of the positions of some important heavenly bodies. The reason for these records was primarily utilitarian. For, man had learned to connect the changing of seasons with the changing positions of these objects in the sky. Since agriculture was strongly dependent on seasons, it was necessary to forecast these, and this is where the primitive astronomical observations helped.

Looking at these records, a curious few . . . began to wonder whether there was any rule or pattern which controlled the motion of stars and planets. The pattern in the case of stars was discerned without much difficulty, but the planets posed more difficulties . . .

This hard problem was solved, according to the present records available, by the Greek astronomers . . . [who] flourished before Christ. . . . These astronomers gave elaborate geometrical construction involving circles, called the epicycles, to describe how planets move when observed from the Earth. With this epicyclic theory they were able to predict where each planet would be at a given time with reasonable accuracy.\*

To have detected order beneath the chaotic motion of planets was a feat of high intellectual order. . . . For several centuries the description of planetary motion as given in Ptolemy's book 'Almagest' was accepted in toto. Indeed, it had achieved the status of religious dogma. . . . [Yet, it was challenged in the sixteenth century] . . .

The central hypothesis of Greek astronomy was that the Earth was a fixed object in space around which the heavenly bodies moved. [In 1473], Nicolaus Copernicus argued that the description of planetary motion became simp-

lified if the Sun was taken as the fixed object. He went on to give his own geometrical constructions to demonstrate this.

In this Copernicus did not achieve any significantly better accuracy than Ptolemy. But . . . his picture is considerably less complicated. Moreover, by pointing to the Sun as the centre-piece, he initiated the next important step: Why do planets move round the Sun? Thanks to the investigations of Kepler, Galileo and Newton, the answer to this question finally emerged. It was Isaac Newton's law of gravitation which accounts for this motion . . .

We can now contrast the scientific outlook with the superstitious approach to natural phenomena. The view that planets exert influence on human destiny still persists, although the original basis for it is gone. . . . Thanks to space technology, man is now on the way to landing scientific instruments on these planets. It should be remembered that the remarkable accuracy of the Viking landing on the planet Mars would not have been possible without a confident application of the laws of science tested through the process of E—O—D.

#### ARE SCIENTIFIC LAWS SUBJECT TO REVISION?

Are the laws of science, as discovered by the above E—O—D method, sacrosanct and unchangeable?

In principle, the answer to this question is "No". A scientific theory or law is acceptable only so long as it fulfils the criterion that it explains—or at least does not conflict with—any phenomenon observed in Nature. Once it fails to satisfy this criterion, it must either be modified or totally rejected. . . .

If a law has been well established for long,

\*In this context 10% accuracy would be considered 'reasonable'.

but encounters a conflict with a series of experiments, the scientist will resort to a revision of the law only when everything else has failed . . . This 'everything else' may include new experiments, a different interpretation of the same law, and sometimes a very far-fetched set of assumptions. . . .

The classic example is the advent of Einstein's Special Theory of Relativity. Towards the end of the last century an experiment on light propagation by Michelson and Morley produced results which simply could not be accounted for in terms of . . . Newtonian physics. The experiment attempted to measure the Earth's motion relative to a hypothetical medium called 'the aether' . . . . Several attempts to measure this motion [failed] . . . . No motion was detected.

Many . . . experienced theoreticians, including Lorentz, Fitzgerald, Poincare and others, attempted to account for this . . . within the existing framework of [Newtonian] physics, . . . but they were not successful. It was not until 1905 when Albert Einstein proposed his revolutionary Special Theory of Relativity that this riddle could be solved. It involved a radical departure from the Newtonian ideas of space and time.

Today Einstein's Special Theory of Relativity is an accepted part of science . . . . Yet its acceptance by the scientific community was not [easy]. Most leading scientists viewed it with suspicion.

Special relativity dealt one blow to the complacency of the nineteenth century science. Quantum theory dealt another. The scientists of the last century, especially after the highly successful electromagnetic theory put forward by Maxwell about a hundred years ago, had been gradually coming to the view that most of basic physics was already known and that only

details needed to be worked out. This view came in for several shocks; . . . while the classical laws of science predicted a continuity in the behaviour of natural phenomena, those on the atomic scale showed a discrete or a 'jumpy' behaviour. Nothing of the classical physics seemed to fit . . . .

The special relativity and the quantum theory together represent the triumph of the scientific outlook in the development of science; . . . it is also a triumph over the innate conservatism of the scientific community.

This conservatism of the scientist is his tendency to seek shelter in the established ideas. In spite of his declared aim of 'objectivity', . . . he tends to be hostile to any new theory or interpretation . . . .

In astronomy today this problem is being increasingly felt. Thanks to the rapid growth of technology after World War II, the astronomer has several new tools at his disposal to probe the Universe.

He is discovering new and weird phenomena in the remote corners of the Universe. Some of these he can interpret by clever extrapolations of his scientific knowledge gained in the terrestrial laboratory. But there are many others which defy explanations. How should one approach these apparently insoluble problems?

Speaking in this connection in the 1970 Vatican Conference, Sir Fred Hoyle, a leading astrophysicist of our time, . . . remarked :

. . . I think it is very unlikely that a creature evolving on this planet, the human being, is likely to possess a brain that is fully capable of understanding physics in its totality. I think this is inherently improbable in the first place, but even, if it should be so, it is surely widely improbable that



this situation should just have been reached in the year 1970.

—*Study Week on Nuclei of Galaxies*, Ed. O'Connell  
(North Holland)

There are some who would join issue with Sir Fred and argue that nothing discovered so far requires a modification of the existing laws of physics. To me such an attitude seems dangerously close to the point of view of scientists of a century ago, which I mentioned earlier.

My own personal view is that we may already be seeing evidence in astronomy that our laboratory based knowledge of physics is incomplete and I will illustrate this point of view by hazarding a guess as to where the break-through may come.

#### THE LAW OF GRAVITATION

In describing the history of man's efforts to understand the motion of the planets, I had stated that the law of gravitation given by Isaac Newton successfully accounted for this motion. This law is simple in its statement but profound in its implications. I will . . . concentrate on one particular feature of it. This is the strength of gravitational attraction. This strength is characterized by the constant of gravitation, usually denoted by the letter  $G$ . The force of attraction between two masses  $m_1$  and  $m_2$  separated by a distance  $r$  is then given by the simple formula

$$\frac{G m_1 m_2}{r^2}$$

Thus the bigger the masses the larger is their mutual attraction and the further apart they are the less is this force. In the terres-

trial laboratory we deal with relatively small masses and so this force is negligible compared to other forces around, such as electricity and magnetism . . . But the situation is quite the opposite in astronomy where we deal with enormously large masses. The mass of the Sun is some two million million million million kilograms. Our Milky Way system is estimated to be a hundred thousand million times as massive as the Sun. There are strong radio galaxies even more massive than our Milky Way. The question is, "Does the law of gravitation operate for such systems in the same way as it does for the Sun and the planets?" The astronomer works on the assumption that it does. But already there are indications that he may be wrong in making this assumption.

A related question is "Does  $G$  remain a constant, or does it change with time?" Newtonian gravitation implicitly assumes that  $G$  is a constant. [In the] general theory of relativity [given by Einstein in 1915], this assumption [is made] even more strongly. What do astronomical facts say?

Recent use of accurate atomic clocks has made it possible for astronomers to check whether  $G$  is constant or changing with time. In principle, observations of the Earth and the Moon should tell us something about this. For, if  $G$  is slowly decreasing with time the Moon will gradually move away from the Earth and go round it more slowly. The present observations indicate that this may be happening although very slowly. If at all,  $G$  may be decreasing by a few parts in a thousand million per century. It is too early to be definitive about this conclusion since it has profound implications for the well established theories of Newton and Einstein. Even if it turns out to be correct, its acceptance by a basically con-

servative scientific community will take some time.

### THE SCIENTIFIC OUTLOOK IN DAILY LIFE

I have given these examples from the history of science and from modern science to illustrate how the scientific outlook has been responsible for whatever progress science has made to date. . . .

However, the scientific outlook need not be the prerogative of the scientists alone.

Indeed, just as in the case of science, progress could be achieved only when the scientific outlook prevailed over the innate conservatism, so in the case of a society of human beings this outlook acts as an antidote to the evils of prejudice and superstitions.

Superstitions are born out of ignorance of how Nature functions. Science is dedicated to the unravelling of the mysteries of Nature. As one particular mystery is solved, we should expect the superstitions based on it to disappear. Yet, this does not always happen in practice. . . .

Now that astronomy has answered most of the questions raised about planets by the primitive man, we should expect [the related superstitions] to [vanish]. Yet this has not happened. Even in the technologically advanced country like the United States. . . . [as] recently as a year ago, a group of 186 leading scientists . . . were signatories to a circular denouncing the [divine powers ascribed to planets].

I give below an extract from their statement:

...It is simply a mistake to imagine that the forces exerted by stars and planets at the

moment of birth can in any way shape our futures. Neither is it true that the position of more favourable to particular kinds of action, or that the sign under which one was born determines one's compatibility or incompatibility with other people. . . . In these uncertain times many long for the comfort of having guidance in making decisions. They would like to believe in a destiny predetermined by astral forces beyond their control. However, we must all face the world, and we must realize that our futures lie in ourselves, and not in the stars. . . .

—*The Humanist*, Sept.-Oct. 1975

Suppose a scientist is asked to examine this question: "Do planets influence human destiny?" How will he go about testing the hypothesis? . . . He will not be satisfied by the prediction by a single person based on a single horoscope. First he will require a set of well-defined rules on which such predictions are based. The rules should be unambiguous so that different persons make the same prediction from the same horoscope. Next he will need to be convinced that these rules work in a statistically significant manner to discount the possibility of the prediction being right purely by chance. This will require a systematic study of a large number of cases under different conditions.

Let me give a simple example. . . . Suppose someone claims to predict with reasonable accuracy whether a tossed coin will fall with 'head' up or 'tail' up. Will a single toss decide the truth of his claim? We all know that any one can predict correctly the outcome with fifty per cent accuracy. This chance element must somehow be reduced. Suppose we ask him to perform this prediction-test 100 times, and he predicts correctly 50 times. Again we will argue that this is not a significant indicator.

of his predictive power. But suppose he is accurate 51 times. Do we give him credit? What if he is accurate 70 times? The statistician. . . has devised tests to decide whether the success achieved in a particular experiment is purely due to chance or due to some other factor. . . It is not always necessary to call upon the professional scientist to perform such tests. The educated common man can himself sift the evidence provided he adopts an objective outlook.

Of the scientific outlook in layman, I can think of no better example than that of James Watt. Seeing the lid of a kettle of boiling water being tossed out he began to wonder about the cause and so arrived at the power of trapped steam. This was the beginning of the technological revolution in England.

#### THE SCIENTIFIC OUTLOOK VERSUS TRADITIONS

India is a country with a long history of refined human culture. It has been, and it continues to be, the home of world's great religions. Its multi-language literature is rich in the thoughts of great thinkers.

Yet, it is up to us to derive the maximum benefit from this legacy. Do we merely stay contented that we had such a glorious past? Or do we heed and follow literally the views of our forefathers. . . ? Or should we pick up the essence of their wisdom and adapt it to the changing circumstances of today's world? To me it seems that by and large our present society is happily following the first two approaches and scarcely bothers to give a thought to the third one even though it appears logically the most important.

Let us take the case of Hindu religion. Its primary sources, the *Vedas* and the *Upanishads*, are said to be without authors. Yet whoever originated them, was (or were) moved by the spirit of rational enquiry which would have done credit to any scientist today. However, this desire to ask questions and seek answers seems to have got lost behind the multitude of meaningless rituals we see around today.

Let me illustrate this by giving an example. Suppose a [man] has to make a business trip on a certain day [which happens to be] inauspicious. . . What should he do? He cannot change the day of the trip for business reasons. . . So he looks for a loophole. On the previous day (which is not inauspicious) he goes out of the house and leaves some token item with a neighbour. He then returns to his house and goes on his trip the next day as planned. His visit to the neighbour is supposed to mark the beginning of his trip. So he has fulfilled his business obligation of the required day without beginning his trip on an inauspicious day. I present this example to you without comment.

Similar examples may be found in other religions. It is characteristic of all great religious thinkers and philosophers that their greatness is motivated by the same spirit of enquiry that drives the great scientists today. Yet, by the time their wisdom is transmitted to the common man, . . . the original humility of the great men is forgotten. Instead their place is taken by the so-called demi-gods or miracle workers.

Partly the common man himself is to blame for this state of affairs. In his desire to avoid the hard work needed for success he is forever on the lookout for shortcut methods. The so-called 'miracles' appear to him the ideal way to achieve his end.

Albert Einstein once said "In this materialistic age of ours the serious scientific workers

are the only profoundly religious people". The scientist is the last person to assert that he knows "all the answers". He is forever asking questions and searching for solutions. . . . But he will not accept anything on trust—just because someone said so.

Unfortunately, the hard-headed scientist is yet to discover a 'miracle' in his investigations of natural phenomena. After years of work he has arrived at certain 'conservation laws' which are obeyed in Nature. These laws have precise mathematical formulations and accurate experimental verifications; . . . A scientific investigation of the so-called 'miracles' one hears of at present would be very rewarding, whatever its outcome. If the 'miracles' are proved to be frauds, the society will rid itself of an evil. If they are proved to be genuine it would mean a great leap forward in the advancement of science. . . .

#### THE SCIENTIFIC OUTLOOK IN A DEVELOPING NATION

Speaking some ten years before independence, Nehru had expressed the conviction that:

... Science alone can solve the problem of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people. . . .

—*Jawaharlal Nehru*,  
Frank Moraes, Macmillan

Indeed, at first sight these problems before us appear to be formidable if not unsurmountable. Yet, we have only to look at the re-

markable progress of science over the last few decades to see that a properly channelled scientific approach holds out hope for the future.

Unlike the so called miracles I mentioned earlier, the miracles of science benefit not one single individual, but a whole class of humanity. You need pure scientists to do basic research, applied scientists to consider applications of science to human welfare and technologists to translate these concepts into reality. You also need educated people to acquaint the masses with what science has to offer and to create a climate in which the common man becomes interested in and receptive to the new ideas of science. The task of popularization of science is a very important one. . . .

The second important point is that we must not denigrate basic research. It would be a shortsighted point of view to argue that basic research is an expensive luxury which a developing country cannot afford. To elaborate this, I . . . reproduce here an extract from the speech made by Dr. Homi Bhabha, the founder of the Tata Institute of Fundamental Research on the occasion of the inauguration of the new buildings of the Institute by Nehru:

... By fundamental research I mean basic investigations into the behaviour and structure of the physical world without any consideration regarding their utility whether the knowledge so acquired would ever be of any practical value. Nevertheless, the support of such research and of an institution where such research can be carried out effectively is of the greatest importance to the society for two reasons . . . . It helps to train and develop . . . young men of the highest intellectual calibre in a society into people who can think about and analyse

problems with a freshness of outlook and originality which is not generally found. . . .

The developed nations have recognized these facts and they continue to encourage basic research. For us to ignore basic research at this stage would mean that we will have to keep on importing new ideas from abroad . . . . Imagine a country which has vast untapped resources of oil, but which will not search for these for reasons of heavy financial outlay. Such a country will for ever be dependent on oil imported from abroad. . . .

The developed countries are beginning to experience some of the ill effects of excessive and

indiscriminate use of science and technology. We should try to avoid evils like pollution, drug addiction, the break-up of the family as a unit, when we seek to solve the existing problems with the help of science. Let us not end up as intellectual barbarians or technological savages, as the developed countries have been sometimes called. It is here, I think that we can draw on our rich cultural heritage—on the wisdom of our forefathers over many centuries. I am optimistic that if we are not blinded by traditions and dazzled by science but keep our eyes open, our country will make a triumphant entry into the year 2001.

□

whether the discoveries attributed to him are indeed justified.

## Aryabhata

B. SHARAN

*Professor of Physics*

*Department of Education in Science and Mathematics  
NCERT*

ARYABHATA's name has been appearing in the Indian newspapers since the first Indian satellite named after him was launched on April 19, 1975. Recently, we celebrated the 1,500th anniversary of his birth.

All this has led some people to ask: did Aryabhata really do something remarkable or are we just trying to make a mountain of a molehill in order to enhance Indian prestige in astronomy? The sceptics cannot be blamed. Aryabhata has been showered with praise: his specific contributions have never been discussed. Such trumpet blowing has led persons of eminence like J.V. Narlikar to remark: "Some people want to credit Aryabhata, also with heliocentric theory—the theory in which the sun is thought to be fixed at the centre of the revolving planetary system including the earth". (*Hindustan Times*, Oct. 31, 1976). The purpose of this article is to answer such questions in a rational way, and to review

### *When was Aryabhata I born?*

India celebrated the 1,500th birth anniversary of Aryabhata from November 2-4, 1976. How do we know that Aryabhata was born exactly 1,500 years ago? Determining the date of birth is really the business of historians. It may be established through contemporary writings, if there are any exist. Luckily, Aryabhata himself gave a clue to his date of birth in his famous book *Aryabhatiya*. The passage (iii, 10) reads: "When sixty sixty-year cycles and three-quarter *yugas* had elapsed (of the current *yuga*), twenty-three years had then passed since my birth". This means that the 3,600th year of the Kali era had just elapsed when Aryabhata was 23 years of age. From this it is possible to work out both the year and the precise date of his birth. The 3,600th year of the Kali era elapsed in A.D. 499, when Aryabhata was 23 years of age. Therefore, he was born in A.D. 476.

The calculation of the date of birth depends upon how precise is the phrase "just elapsed" and its interpretation. If the phrase is taken to mean the ending of the 3,600th year of the Kali era and the beginning of the 3,600th year, then, according to the Indian *Panchang*, the date and day must be that of the autumn equinox or *mesa-sankranti*—when the sun enters into the Aries. The autumn equinox is associated with March 21. Accordingly, it can be said that Aryabhata was born on March 21, A.D. 476. According to *nirayana* or *sayana*, *mesa-sankranti* occurs on April 13 (Baisakhi day), when the sun enters into the *nirayana* sign

**Aries.** The Bihar Research Society, Patna, thus celebrates the birth anniversary of Aryabhata on April 13. Summing up, it can be said that Aryabhata I was born on the *masa sankranti* of A.D. 476, which works out to be March 21, A.D. 476 and April 13, A.D. 470 on the *nirayana* or *sayana* calendar respectively.

#### *Geodynamic theory—speculation or substantiated fact?*

Aryabhata I is said to have declared, a thousand years before Copernicus, that the earth was not stationary but in perpetual motion. Was this assertion based on reasoning, or was it just speculation? It would decide if Aryabhata can be credited with the discovery. Most of our writers have not bothered to go into this.

Aryabhata's assertion was contrary to the beliefs of his time. He was bitterly criticized even by later astronomers for holding views against the accepted geocentric theory, according to which the earth was at the centre of the universe. This leads us to believe that Aryabhata could not have propounded the geodynamic theory without solid reasoning. On this hunch, the author has been able to find at least three arguments used by Aryabhata in his text *Aryabhatiya* in favour of the geodynamic theory. The arguments relate to the explanation of (i) the apparent motion of stars, (ii) the rising and setting of the planets, and (iii) the eclipses of the sun and the moon.

#### *The apparent motion of stars*

In Chapter IV of the *Aryabhatiya* (iv, 9-10), Aryabhata argues:

"Just as a man sitting in a boat going forward sees a stationary object moving backwards, so at *Lanka* (a hypothetical place at 0° latitude and 0° longitude) do the immovable stars appear to move westwards. (It appears as if) the entire structure of the asterisms together with the planets moves to the west of *Lanka*, being constantly driven by the provector wind, to cause their rising and setting."

Regarding the motion of the earth, in Chapter I he states that in one *prana* (four seconds) the earth moves 1' and makes 1,58,22,37,500 rotations in 43,20,000 years.

#### *Motion of the planets*

The word planet literally means one having an irregular motion. In Indian literature, especially *Panchang*, one comes across terms like *vakri* (retrograde), *margi* (regular), *uday* (visible in the sky, or a planet which rises above the horizon) and *ast* (invisible, or a planet which does not rise above the horizon). The last word in common parlance also means *tara dub gaya*. When a planet sets (*ast*), the holding of many important functions and ceremonies is forbidden in some parts of India. The phenomenon of retrograde motion and not rising up above the horizon for some time are peculiar to planets. They cannot be explained in terms of the geocentric theory, according to which the earth is considered to be at the centre of the universe. In this context, Aryabhata, in a passage ascribed to him, says: "The structure of the asterisms is stationary. It is the earth itself which, making a rotation every day, causes the rising and setting of the stars and planets."

This supports the geodynamic theory—it is the rising (*uday*) and setting (*ast*) of planets,

their changing distance, unlike asterisms (or constellations) which keep the same distance between their stars irrespective of time, that is difficult to explain on the basis of the geocentric—geostatic theory.

Aryabhata further says: "A planet, when faster than its *ucca*, moves westwards on the circumference of its epicycle and when slower than its *ucca*, moves eastward on its epicycle." This is an attempt similar to that of the Greek astronomer Ptolemy to explain the irregular motion of planets.

It may be remarked that the epicycles of Ptolemy are of fixed dimensions, but those of Aryabhata vary in size from place to place. The variable (or pulsating) epicycles probably yield better results than those of Ptolemy's.

#### *Eclipses of the Sun and the Moon*

The popular belief in the days of Aryabhata was that eclipses were caused by the demon Rahu. Aryabhata for the first time asserted in Chapter IV of the *Aryabhatiya*,

"*The moon obscures the sun and the great shadow of the earth obscures the moon*".

When at the end of the lunar month (at new moon), the moon, being near the node, enters between the sun and the earth, or when, at the end of half-month (at full moon), the moon enters the shadow of the earth, which occurs sometimes before and sometimes after the exact end of the lunar month of half-month. There is no Rahu other than the moon who eclipses the sun.

For predicting solar eclipse, Aryabhata says:

"When the disc of the sun and the moon come into contact, a solar eclipse should not be

predicted when it amounts to one-eighth of sun's diameter (or less) as it may not be visible to the naked eye on account of the brilliancy of the sun.

From the arguments cited for explaining the phenomena of the (i) apparent motion of the stars, (ii) the rising and setting of the planets and (iii) the eclipses of the sun and the moon, Aryabhata's assertion about the geodynamic theory does not appear to have been a matter of speculation but based on solid reasoning.

#### *Aryabhatiya*

Quotations from the *Aryabhatiya* have been frequently used in this article. A brief description of the work will be in order. It contains only 121 stanzas whose explanations may require hundreds of pages. It is a masterpiece of brevity and conciseness of composition. The other similar work in Indian literature I know of is *Patanjali Yog Darshan* (पातञ्जलि योग दर्शन).

The *Aryabhatiya* consists of four chapters—*Dasgitika-pada*, *Ganita-pada*, *Kalakriya-pada* and *Gola-pada*. The word *pada* literally means 'quarter'. *Patanjali Yog Darshan* also has the same number of chapters.

Chapter I, *Dasgitika-pada*, has 13 stanzas. It deals with the larger units of time and distance such as *yuga* and *yojana*. One *yuga*, popularly known as *chataryugi*, is the time taken by the planets to return to the same configuration, which is 43,20,000 years. On this scale, the *kalpa*, or one day of the creator Brahma, comes to 4,320,000,000. This is remarkably close to the modern time scales associated by the astronomers with the evolution of the universe. It also gives the diameters of the earth, sun, moon and the planets, the obliquity of the sun with respect to the celestial equator, and a table of sine-differences.



Chapter II, *Ganita-Pada*, consists of 33 stanzas and deals with topics such as properties of geometrical figures, quadratic and linear indeterminate equations, the arithmetical methods for extracting the square root and cube root, the method of constructing sine table, etc.

Chapter III, *Kalakriya-pada*, consists of 25 stanzas dealing with the true positions of the sun, moon and the planets. They explain the motion of the sun, moon and the planets in terms of eccentric circles and epicycles and suggest methods for computing the longitudes of the sun, moon and the planets.

Chapter IV, *Gola-pada*, consists of 50 stanzas. It deals with the motion of the sun, moon and the planets, the calculation and graphical representation of the eclipses and the visibility of the planets.

Aryabhata had also determined the value of  $\pi$  as 3.1416 correct up to five significant figures.

For other contributions one can refer to *Aryabhata—Indian Mathematician and Astronomer* by K.S. Shukla, published by the Indian

National Science Academy, Bahadur Shah Zafar Marg, New Delhi.

Aryabhata was considered to be the saviour of Indian astronomy. The ancients paid him tributes: "When the methods of the five Siddhantas (Paitamaha, Saurya, Vasistha, Romata and Paulisa) began to yield results conflicting with the observed phenomena such as the setting of the planets and the eclipses etc. there appeared in the Kali age, at Kusumapuri (Palaliputra or modern Patna) Surya himself in the guise of Aryabhata the *kulapa*\*, well-versed in astronomy." As far as we are concerned, the most fitting tribute would be to remember him as the father of scientific astronomy in India.

□

---

\**Kulapa* means *kulapati* or head of a university. It is surmised that Aryabhata was *Kulapati* of the University of Nalanda situated in the modern district of Patna. An astronomical observatory was a special feature of this university. It existed at *Khagula*, near Patna. *Khagula* is corrupted form of *Khagola* meaning 'celestial sphere'.

---

## Werner Heisenberg : A Revolutionary in Physics

R.P. BHATIA

*Lecturer in Physics, NCERT*

HEISENBERG was among the giants of twentieth century physics. It was Heisenberg who, in the 1920's, revolutionized quantum physics from the germinal ideas of Max Planck, Einstein and Niels Bohr.

Heisenberg was born on December 5, 1901, the year Planck postulated the quantum nature of black-body radiation. In a certain sense, Heisenberg's life ran parallel to the birth and development of the new physics:

Werner Karl Heisenberg was born of distinguished parents. His father was a professor at Wurzburg, Germany, where Werner Heisenberg was born. He was an exceptionally brilliant and hard-working student and under the inspired guidance of the equally brilliant Arnold Sommerfeld, obtained his doctorate in theoretical physics from the University of Munich in 1923 when he was only 22 years old. In the same year, he became *privatdozent* and assistant to Max Born at Goettingen where he was appointed lecturer in 1924.

But in those days, Copenhagen, under Bohr, was the centre of theoretical physics. Bohr had attracted leading physicists like Landau from Europe and elsewhere. Bohr was at that time the doyen of modern physics. He had extended Planck's and Einstein's postulates of energy quantization by assuming that the electron orbits of the hydrogen-atom were also quantized. Although he had succeeded in explaining the spectrum of hydrogen, he had raised some fundamental philosophical problems. For physicists who had been impressed by the successes of classical (Newtonian) mechanics in a wide variety of physical conditions, it was difficult to reconcile to its apparent failure in the domains of black-body radiation and atomic physics. Was it justifiable, they argued, to bring in the new quantum physics, whose postulates were contradictory to those with which they had been familiar all their lives?

Bohr introduced the 'correspondence principle' to explain the mixture of classical and quantum ideas in his theory. But it was left to Heisenberg to rigorously develop these ideas and to free them from their classical constraints. In the words of Edward Teller, who subsequently became Heisenberg's student and is today a distinguished physicist in his own right:

"Where Bohr navigated a new ocean keeping the shore of classical physics in sight by the use of the correspondence principle, Heisenberg left the old land and sailed beyond the point of no return."

It is remarkable that Heisenberg was not familiar with matrix algebra when he developed the 'matrix mechanics' method of quantum mechanics. In a similar way, Einstein had been unaware of tensor algebra when he pro-

duced the general theory of relativity. Both of them reinvented the mathematical tools they required for their physical theories. Shortly afterwards, Schroedinger, another German physicist, developed the 'wave mechanics' approach to quantum mechanics. The two approaches were subsequently shown to be equivalent.

Heisenberg stayed in Copenhagen for three fruitful years. His other major contribution of those years was the invention of the 'uncertainty principle' which sets limits on the accuracy to which the position and momentum (or any other two 'conjugate variables') of a quantum particle can be determined. This principle has far reaching effects in quantum and nuclear physics where classical ideas are grossly inadequate. The Japanese physicist Yukawa predicted a new elementary particle called 'meson' with arguments based on this principle.

On his return from Copenhagen in 1927, he was made professor of theoretical physics at Leipzig. He was to remain there till 1941. At Leipzig, he did some important work in nuclear and solid state physics. He introduced the idea of 'isotopic spin' which places the nucleons—neutron and proton—on an equal footing, the charge difference between them being just two 'states' of the same particle.

This idea has been very fruitful and has become an indispensable tool of today's theoretical physicists. Heisenberg was awarded the Nobel Prize for physics in 1932 for his discovery of quantum mechanics and its implications in atomic and nuclear physics. But his subsequent work could have earned him another Nobel Prize.

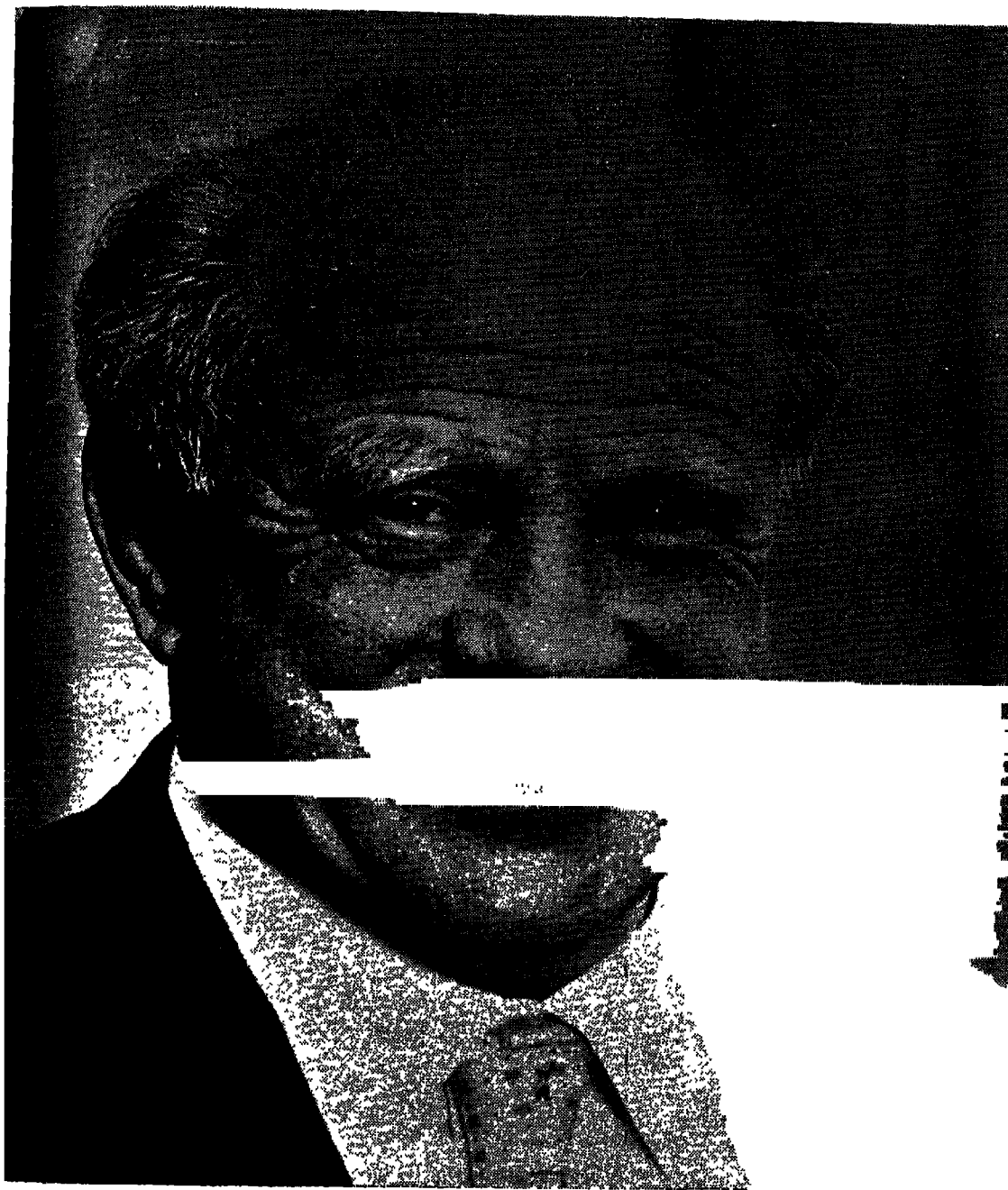
It was at this time that Nazism started raising its ugly head in Europe. Many distinguished European scientists and scholars like Einstein, Enrico Fermi, Max Born and

Eugene Wigner fled Europe. Heisenberg visited U.S.A. in 1939 and was urged by many people to stay on. But on the advice of Planck, and on account of his own patriotic sentiments, he refused. He decided to remain in Germany during the Second World War, even though many scientists accused him of being a Nazi sympathizer. He worked on, hemmed in by the atrocities and madness of the war. He worked on the problem of fission which had recently been discovered. And his unceasing efforts helped save the lives of several physicists caught in the war.

When the war ended, Germany lay in ruins—physically, economically and morally. The war had taught Heisenberg a bitter lesson: another world war must be avoided at all cost. For, even if man survived yet another war, it was difficult to imagine how his spirit would stand the trial.

Even during the war, Heisenberg had anticipated the destruction of Hitler and the fall of Germany, and he had pondered over the problem of reconstruction in the post-war period. With most of the eminent scientists having emigrated to U.S.A. and other countries, the role of rebuilding German science was thrust upon Heisenberg. In 1946 he became the director of the Max Planck Institute at Goettingen and in 1953 he became the president of the Von Humboldt Foundation, which gives scholarships and guidance to scientists working in Germany. He was also involved in harnessing the phenomenon of atomic fission for peaceful uses.

While he became more and more occupied with the problems of post-war reconstruction and with administrative details, Heisenberg did not altogether give up work in the fundamental problems of physics. He became interested in plasma physics and the 'S-matrix'



WERNER HEISENBERG  
1901-1976

theory, and he elucidated the philosophical implications of the new theory he had built. He also attempted to construct a 'unified field theory' in 1953. Besides these efforts, he wrote books and monographs not only on physics, but also on philosophy and on Germany's new role in the scientific community. Pre-war Germany boasted of a galaxy of scientists, engineers and philosophers: after the war few remained. Heisenberg's endeavours were directed at rebuilding German science and technology. We can see that his efforts have succeeded.

Apart from his interests in physics and philosophy, Heisenberg was an accomplished musician and an enthusiastic outdoors man. He loved to go out for long walks and regaled his friends with his conversation. He loved his country deeply, remaining in Germany when others had forsaken it. Above all, he was a humble and unassuming man. A friend

of mine recalls the time when he went as a research scholar to the Max Planck Institute where Heisenberg was director. My friend recalls that he was shown around the institute by a kindly old man with grey hair. Afterwards, he enquired after the nice old man who had been so helpful to an unknown Indian research scholar. "Don't you know—he was Heisenberg himself!"

Heisenberg retired from his professorship in 1971. He was then made director emeritus of Planck Institute. He led a peaceful, sedate life with his wife Elisabeth, whom he married in 1937. He had three sons and four daughters. He died quietly on February 1, 1976, having lived a long, purposeful life. In his youth, he carried physics to uncharted frontiers. In his old age he rebuilt the great scientific tradition of Germany which had almost been completely shattered by Hitler and the Second World War.

□

---

### *The Riddle of the Beginning of Beginning*

—A VISION OF THE MACROCOSM

Accepting the usual laws of physics, the observed expansion of the Universe implies a singular origin for the Universe. Since gravitation is attractive and tends to slow down the expansion, the fact that the Universe is expanding at present implies that it was not only expanding in the past, but that the speed of expansion was faster than it is now. The obvious question arises: If there has always been expansion, from what has the Universe expanded? A simple calculation shows from a state of infinite density. . Yet the state of infinite density must have occurred some ten billion years, or less, ago. This in itself is more surprising than objectionable. The objection arises when one asks what was the situation before that? No answer to this critical question has yet been given from the standpoint of orthodox physics. One might speculate that perhaps there was a previous phase in which the Universe contracted from a dispersed state into an extremely high-density condition, which formed the beginning of the present epoch of expansion.

—"Astronomical Studies, Problems and Speculations", *Encounter with the Future*,

FRED HOYLE, *Credo Perspectives*,  
Simon and Schuster, New York, 1968

---

## Nobel Prizes in Science 1976

---

*"I still think my best work is ahead  
of me"*

---



*Chemistry:* WILLIAM N. LIPSCOMB

Dr. William N. Lipscomb of Harvard University won the prize for his work in the chemistry of boranes—compounds of boron and hydrogen.

Dr. Lipscomb's work, which was influenced by another Nobel Laureate, Linus Pauling of the California Institute of Technology, had led to the transformation of boranes from a toxic explosive substance to a compound used now in drugs to treat mental illness and brain tumors. Boranes may also one day be upes against cancer.

Referring to this latter potential, Dr.

Lipscomb said: "I still think my best work is ahead of me." The use of boranes to fight cancer is "still preliminary and we have a much longer way to go," he said.

The 56-year-old Dr. Lipscomb has spent 20 years in studying boranes. He was the first to establish their structure and to grow borane crystals in the laboratory where they could be studied with x-rays. His techniques of x-ray diffraction have proved useful in other areas of chemistry as well.

In the citation for chemistry, the Academy




---

*Looking into the mechanism of the origin and dissemination of infectious diseases. . .*

---

***Physiology & Medicine:* BARUCH S. BLUMBERG**

also praised Dr. Lipscomb for his "eminent work. . . in other fields of chemistry. . . (such as) notable findings in studies of the structure and mechanisms of enzymes."

Dr. Lipscomb graduated from the University of Kentucky and received his Ph.D. from the California Institute of Technology.

The prize for physiology and medicine was awarded to Professor Baruch S. Blumberg of the University of Pennsylvania Medical School and Professor D. Carleton Gajdusek of the National Institute for Neurological Diseases at Bethesda, Maryland, for "their discoveries concerning new mechanisms for the origin and dissemination of infectious diseases."

Both the scientists found major clues to their work while studying primitive tribesmen in the South Pacific.

Dr. Blumberg discovered the so-called Australia antigen in the blood serum of Australian aborigines.

[An antigen is a chemical that stimulates production of the certain antibodies that in turn fight off disease in the body.] The antigen was identified as part of the virus that causes the most severe form of hepatitis, a liver disease.

Dr. Blumberg's discovery has since led to the production of an experimental vaccine for the hepatitis virus, as well as a test for the disease used in screening blood donors. He hopes the vaccine—or a form of it—can eventually be used to treat a liver cancer found in parts of Africa, South China, Taiwan, The Philippines and Malaysia.

While studying the blood serum of the inhabitants of Surinam, Nigeria, Singapore, India, the Arctic and the Marshall Islands, to mention a few locations, Dr. Blumberg

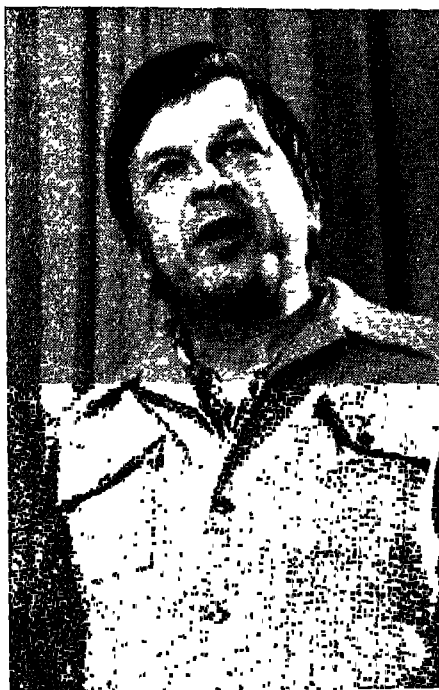
became a medical anthropologist, a doctor who studies why people with different social and hereditary backgrounds have different responses to diseases. He now teaches a course in medical anthropology at the University of Pennsylvania. He was born in New York City and received his Ph.D. in biochemistry from Oxford University.

D. Carleton Gajdusek's award-winning work began in New Guinea, where he had gone to investigate the cause of a fatal disease called "Kuru." There he discovered a virus, transmitted through a primitive tribal custom of eating human brains, which also has implications for a number of other fatal diseases around the world.

The virus Dr. Gajdusek isolated in New Guinea, where the disease has now disappeared since the custom has been abandoned, is similar to other pathogens known as "slow viruses." These are believed to be the cause of a number of nervous disorders including multiple sclerosis and Parkinson's disease, as well as "scrapie," a sheep disease that causes a breakdown of the nervous system. These viruses are extremely hard to isolate (they are very small) and hard to kill. They are resistant to high temperatures, ultraviolet light and strong chemicals.

Dr. Gajdusek continues his research on "slow viruses," and is also an expert in pediatrics, genetics, immunology and neurology

Dr. Gajdusek was born in New York of Hungarian parents. He received his degrees from the University of Rochester and Harvard Medical School and joined the National Institute of Health in 1958. He is unmarried, but has 16 adopted boys whom he brought to the United States from New Guinea and other



D. CARLETON GAJDUSEK

---

*He discovered a virus transmitted through a primitive tribal custom (in New Guinea) of eating human brains. . . .*

---






---

*A look into the "building blocks" of matter*

---

*Physics:* BURTON RICHTER

South Pacific islands. While seven of the young men have married and moved to their own homes, the remaining nine live with Dr. Gajdusek in Maryland or at his family home in Yonkers, New York. He will use his prize money to "send his boys through college," he says.

The prize for physics was awarded jointly to Professor Burton Richter, 45, of the Stanford Linear Accelerator (SLAC) in California and Professor Samuel C.C. Ting, 41, of the Massachusetts Institute of Technology (M.I.T.) for their discovery of a new kind of elementary particle named "PSI" by Dr. Richter and "J" by Dr. Ting. Their independent discoveries occurred within months of each other in 1974 and have subsequently revolutionized the field of

physics. A landmark in the search for the "building blocks," or smallest things in nature, the discovery may soon lead to a unifying theory to describe *the behaviour of all matter*.

For years, the atom was thought to be the indivisible, immutable building block of nature. Then came the discovery that the atom was made up of the electron, which orbits the nucleus, and the nucleus made up of a proton and neutron. The electron is fundamental—there is nothing inside it. But research in accelerators, where protons are bombarded at very high energies, had hinted that there was indeed something inside the proton.

Ten years ago, Professors Murray Gellman and George Zweig, now both of the California Institute of Technology, theorized that the "something" inside the proton and neutron was "quarks," the true building blocks, along

---

*Reaching into the heart  
of the matter. . .*

---



SAMUEL C. C. TING

with the electron, of all nature. At the same time, Professors Sheldon Glashow of Harvard and James Bjorken of Stanford theorized that there should be four kinds of quarks: two found in all ordinary nature such as trees, flowers and people, and two others found only in accelerators where particles were studied. These latter two were called "STRANGE" and "CHARM". The property of STRANGE had been verified at the time of the Richer-Ting discovery. But that of "CHARM" had not been, thus leaving in question the entire quark theory of nature.

The discovery of the "J" or "PSI" electrified world physicists. Since the particle appeared to exhibit "CHARM", it lives only a fraction of a second, short by human standards, but 1,000 times longer than other particles. And it was heavy, nearly four times the mass of the proton. Since 1974, the "CHARM" property of the "J" and "PSI" have been verified with other discoveries at

Stanford and at the Fermi National Accelerator Laboratory in Batavia, Illinois.

"Before the discovery of the new particle, you had a theory of quarks and CHARM you just couldn't believe," said Dr. Robert March of the University of Wisconsin, who also works in the field. "The discovery was the capstone in the arch, the last piece in the puzzle. We now have a picture of nature that will not change in any of its basic ingredients for some time to come," he said.

"This is the greatest discovery ever in the field of elementary particles," said Professor Goesta Edspong of the Swedish Royal Academy of Sciences. "It has changed the workstyle of all laboratories throughout the world. . . (where scientists) are now chasing the new forms of matter which this particle promises," he said.

While the discovery may lead to a new theory to unify all theories of nature, it might also lead to an understanding of *what matter*

is. With this understanding, science would then make up particles of matter that could be tailored and used to do, or build, whatever was needed.

Dr. Richter was born in New York in 1931, received his Ph.D. at the Massachusetts Institute of Technology in 1956 before going to Stanford where he built the instrument that led to his discovery—the “Storage Ring” facility that is connected to SLAC, the two-

mile linear accelerator.

Dr. Ting was born in the United States of Chinese parents and grew up in China where he had no formal education until he was 12. He received his Ph.D. at the University of Michigan and has worked at the University of California at Berkeley and Columbia. He now divides his time between M.I.T. and the European Nuclear Research Centre in Geneva. □

—Courtesy: USIS

### *Gravity : After Newton—After Einstein*

Newton had said in the *Principia* that, “Any two bodies attract one another with a force [gravitation] which is proportional to the product of their masses divided by the square of the distance between them.” The description of gravity as an active force that makes its power felt in some unexplained manner did not satisfy Einstein. . . .

Everything he did reminded him of gravity. . . . He was pondering the way a magnet calls a magnetic field into being around it one day when he went to an outdoor cafe—a center of intellectual as well as social life in Prague.

“Having another big idea, Albert?” called his friend the physicist Anton Lampa, seated at a table under the trees.

“An idea at least,” Albert replied jovially as he walked over to join Lampa and his friend George Pick, an imaginative mathematician almost twenty years Einstein’s senior.

Einstein ordered a bowl of soup, but pushed it aside after a few spoonfuls. “When you toss a pebble into a pond,” he said, “the eddies make circles in the surface of the water. Is it possible that the whirling of the earth, moon, and stars creates similar eddies in space?” . . .

“If they do,” said Einstein, “then the sun, moon, and stars could call into being a gravitational field in much the same way that a magnet calls a magnetic field into being.”

“How will you prove this?” asked Pick.

Einstein [said], “James Clerk Maxwell described the structure of a magnetic field through equations. I hope to do the same for the gravitational field.”

—Albert Einstein: *Theoretical Physicist*,  
AYLESA FORSEE, Macmillan, 1964

# Teacher Training Programme

## *How it can be made more effective\**

B. GANGULY

*Professor, Department of Education in Science and Mathematics, NCERT, New Delhi*

IN THE year 1970, nearly 12,000 primary teachers were trained under the Unicef Science Education Programme. Like any other curricular enterprise, the success of the Unicef-assisted Science Education Programme depends largely upon the teachers. They are to be properly prepared to act as the most important instrument to handle the textbooks, kits, and other teaching aids and guide the activities effectively so that the objectives of this new curriculum are duly fulfilled.

Accordingly, the courses of training schools and colleges have been modified to meet the requirements by improving the preservice training. Side by side, extensive training programmes are being organized to clear the backlog of untrained teachers. Such short term inservice training programmes are, at the most, of one month's duration and are meant to make the teachers familiar with different

components of the curriculum. At the same time, they are meant also to bring about certain positive changes in their behaviour so that they can help towards the fulfilment of the objectives of the Science Education Programme. Together with the training of primary teachers, orientation programmes for the method masters, educational administrators, laboratory technicians and craft teachers are also being organized.

The present article attempts to identify some of the weaknesses associated with the present teachers' training programmes and offers suggestions to eliminate them.

For convenience of discussion, the present article deals with those inservice programmes which are organized by the States for the Unicef-assisted science education programme for the training of primary school teachers. But certain points are, perhaps, equally applicable to the training for the teachers of other levels and also for summer institutes and different preservice courses.

### *Organization and objectives of inservice training programmes*

In order to understand the weaknesses of the training programmes, it is necessary to know how they are organized, what their objectives are and which steps are followed to fulfil these objectives.

These inservice training programmes for the primary teachers are usually organized at

---

\*Presented at the Training Course-cum-Seminar of Senior Officers of Education Department, Govt. of Uttar Pradesh, on Science Education, at Allahabad on 4th and 9th October, 1970.

the block level in a high school or a similar institution. The number of participants vary from 30 to 40. Participating teachers from distant places reside in the training centre. Most of the participants come with the previous experience of attending orientation programmes elsewhere (family planning, health, etc).

In each training programme, three to four resource persons are invited, who are either officials of State Institutes of Science, or graduate science teachers of high schools. All these resource persons, however, have had a prior orientation regarding the curriculum.

*The training programme includes the following components:*

- (a) Discussion about objectives—general and specific;
- (b) Content of all the units, and methodology of teaching;
- (c) Introduction of the kit items: their use and maintenance;
- (d) Demonstration of the kit equipment;
- (e) Student activities;
- (f) Field trips;
- (g) Film shows;
- (h) Evaluation.

Through lectures and lecture-cum-demonstrations, the resource persons introduce the items *a—e*. The participants handle the kit equipment themselves, perform the activities following the directives of the resource persons. The items *f—g* are ceremoniously observed in all training programmes, but are taken rather less seriously. One day (usually a Sunday or near the end of the programme), the participants are taken to places of local interest,

like botanical gardens, the zoo, a historical monument or a factory, more with the spirit of a pleasure trip. Similarly, film shows are arranged and films on primary science shown—more for relaxation than education.

The evaluation is performed by testing the participants through a questionnaire at the end of the programme. But the real impact of the training programme is seldom evaluated because the participants are never pre-tested before the programme.

It is expected that at the end of the training programme, when the teacher will go back to the school, he/she would be able:

- (i) to explain effectively the concepts to the students by using different methods of teaching, so that the objectives of both cognitive and affective domain are fulfilled;
- (ii) to handle and maintain the kit properly;
- (iii) to demonstrate different experiments by using various items of the kit;
- (iv) to prepare and use different types of teaching aids;
- (v) to organize field trips and student activities and enthuse the students;
- (vi) to evaluate the learning outcome of the students and on the basis of that modify his/her own teaching method.

*How far the expectations of a training programme are fulfilled*

The participants join the training programme with a doubtful mind. They assume that it is going to be some kind of a new burden for them to bear. This doubt, however, gradually clears away in course of the

programme. On completion of the programme, the participants leave with a sense of achievement. This is a hopeful sign for the Unicef-assisted training programmes which have to be maintained at any cost.

In spite of this enthusiasm, teachers are confronted with certain problems which prevent them from implementing their training. It is necessary to take care of these difficulties which are mentioned below, otherwise the enthusiasm generated in a training programme will soon die off and frustration follow. The problems which worry the teachers are, in their own words:

1. . . "How can I use these demonstrations and the new activity-oriented teaching in my school where I am the only teacher who has to teach all the subjects in all the five classes?"

2. . . "I never read science before. It was interesting to learn the content in the training programme, but as soon as I was back at my school, I forgot many things. When I read the textbook again, I find it difficult at many places and what bothers me most is the language."

3. . . "During demonstration or activity, students ask a number of questions about the equipment, their proper set-up, etc. I find it difficult to cope with these questions. Once I asked them to examine the parts of a flower which is locally available. They brought roses, marigold, bougainvillea and asked me to show the parts. I could not. In the next vacation I went to a local college and learnt that these are not typical flowers. I wish I was told this in the training programme."

4. . . "We were told about different methods of teaching science. But our problem is to select the right method for a particular unit. We wish all the new methods of teaching were actually demonstrated in the training

programmes."

5. . . "The teaching of content takes so much time that it is not possible to see the growth of scientific attitude among the students."

6. . . "All the demonstrations and activities shown in the training programmes are based on the kit. What shall I do if I do not get the kit? And what shall I do if some items of the kit are lost or are out of order? Shall I suspend new methods of science teaching till the new kit arrives, or have the items replaced?"

7. . . "I am teaching in a school in a remote rural area. My students are not mentally prepared to receive the information given in the textbooks. When concepts given in the text are explained, instead of being curious, they often become bewildered and cannot form any mental image. Many of them feel that science is not for them. Is it not possible to present the concepts through the child's own observation? Is it not possible to give activities which the child finds in his own environment?"

8. . . "While I try to enrich myself in the training programme, I always feel that I am intellectually poor. All my experience of 10 years, as a teacher, has no value in this new kind of curriculum. No one is willing to listen to my difficulties, my problems and my suggestions. The resource persons call me "tumb", some of them sarcastically. Everybody is eager to teach me, but no one attempts to get me involved. . ."

9. . . "My principal has told me that all new methods are good but most important is the completion of the course in due time. Otherwise, the school will be put into trouble. How can I, in this situation, take the risk of adopting methods which are new to me? If the course remains incomplete, if the students do

not secure good marks, what would happen to me?"

### *Remedies to the problems of trained teachers*

Some of the problems presented above by the teachers are genuine and the training programmes, as they are organized today, do not answer them.

It is evident from the organization of the training programme that the participants are invariably considered poor (economically as well as intellectually). They are treated with sympathy, but rarely their experience and abilities are properly valued. It is true that the resource persons in most training programmes address the participants as "lun", talk sarcastically, and train them in a way as if they were going to teach for the first time and they were going to teach science only. One training programme of 40 participants is managed by 3-4 resource persons, whereas, after training, each participant will have to teach 40 students. This simple fact is never taken into consideration in the training programme.

The foremost task to make the training programme effective should be to make the training more realistic. The participants should be involved in the work. This may be done on the very first day by discussing with the participants their difficulties, their experience and their expectations from the training programme. The entire training programme, instead of being resource-person-centred, should be made participant-centred.

Every day, at least one hour should be marked for the reading of the text. Let the participants find out their difficulties about the textbook and get them cleared.

While presenting the content of each unit, the resource person should stress on the following components: (i) Questions which the children often ask, (ii) Activities to answer those questions (at least some of them), (iii) What is the relevance of studying a particular unit?

While presenting the items of the kit, improvisation with locally available materials should be highlighted. There is a lot of fun in it and at the same time it stimulates the participants to be truly involved with their work. It also minimizes the total dependence on kit items.

A majority of the teachers come from single-teacher schools. Sufficient care should be taken to show how the teacher should organize his classes and how he can integrate components of science with those of other areas.

With the majority of the teachers, not having a science background and most of them being from places where resource persons and materials are lacking, it is necessary to provide them with printed (cyclostyled) materials giving additional information.

Instead of holding lectures on new methods of science teaching, it is essential that those new methods are demonstrated in the training programme and a clear picture is presented about a particular method of teaching to be followed for a particular unit.

The educational use of films and field trips must be emphasized during the training programme. Films, however, are not the only teaching aids. Teachers can use newspaper cuttings, advertisements, pamphlets as teaching-aid materials. At present, training programmes lay emphasis on the objectives of cognitive domain only. It is necessary to bring a balance

between the cognitive and affective objectives. In order to fulfil the objectives of affective domain, it is necessary to know how to personify teaching. For the purpose of personification, a teacher must know how to identify the needs of a child, how to accept, how to respond, or, in other words, how to react to the actions of the child. In the training programme, it is essential to point out how to make the teaching child-centred and how best the teacher can use "self" as an instrument to combine his ability with the child's need and the requirements of the textbook. The textbooks, kits and other things should be the "means" and not the end of teaching. A training programme would be really effective only if it is possible to show how these "means" are to be used in the teaching.

It is to be ascertained, in all training programmes, that participating teachers have

learnt the following:

- (i) How to provide activities to the students, which offer academic challenge and also the maximum chances of success.
- (ii) How to give personal attention to each student as much as possible.
- (iii) How to promote an atmosphere of cooperation rather than competition.
- (iv) How to permit maximum freedom to the students.
- (v) How to accept errors and mistakes of the students.

The training of primary teachers for the new science curriculum should be something more than classroom teaching. It must involve the teachers completely in the art of teaching. The teacher has to feel that it is his own programme and not something which has been imposed upon him. □



## Pollution—A Case Study

S.P. KANWAL,

*Department of Biology, D.A.V. College, Amritsar*

THE agonized voices against pollution are all around us. These may be of scientists, politicians, statesmen or men in the street. All of them now appear concerned about the dragon of pollution, which is devouring everything pure and clean and egesting whatever is foul and harmful. The quality of man's environment is changing at a tremendous speed.

Even low level pollution aggravates certain diseases like (i) non-specific infections, upper-respiratory diseases (includes "common cold" as well), (ii) chronic bronchitis, (iii) chronic contractive ventilatory disease, (iv) pulmonary emphysema, (v) bronchial asthma, and (vi) lung cancer.

Materials, structures, machines, and property values—all suffer. Metals corrode, fabrics weaken and fade, rubber cracks and loses elasticity, leather weakens and becomes brittle, paint discolours, concrete and building stone discolour and erode, glass is etched, and paper becomes brittle. Complex and expensive control systems, which have become so commonplace in modern technology, can be ruined or seriously damaged by the corrosive action of gaseous

pollutants or by the deposited dust. And coming closer to the average citizen's daily life, air pollution occasions household expense in terms of necessity for more frequent painting and bigger laundry bills.

The problem of pollution, which was quite insignificant a few years ago, has acquired gigantic proportions. Sometime ago, U. Thant the late Secretary General of UN expressed his fears about this horrifying and dreadful threat to humanity:

'For the first time in the history of mankind, there is arising a crisis of world proportions involving developed and developing countries alike—the crisis of human environment. It is becoming apparent that if current trends continue, the future of life on the earth could be endangered.

The various aspects of pollution—atmospheric pollution, water pollution, the pollution of the seas, oceans, lakes and rivers, noise pollution, etc. are the different forms of the many-headed Hydra of pollution. All these are correlated and complementary to each other.

Polluted water is taking a heavy toll of over two million lives every year. There have been instances of clean, piped water mixing up with impurities from the sewage. The pollution of the rivers in both developed and developing countries is increasing at a menacing speed. The unchecked flow of the cities' waste, dirt, refuse, and industrial wastes into the rivers is making them more dirty every day.

The natural pure air is being polluted every day. Our mother earth, considered to be the Garden of Eden, is becoming day by day a wasteland. The fertile lands are becoming

barren. Soil erosion is all around us. In a Unesco-sponsored conference on "Man and Biosphere" held in October 1975 in Kathmandu, soil erosion was labelled as man's Enemy No.1.

The once beautiful green blue waters of the oceans and seas are changing their hues. The food chains and food webs, which are imperative in maintaining ecological balance and ecosystems, are breaking. The whole ecological complex, considering the world as an ecosystem, is affected, not of one country but of the entire world. The stability of firmly set ecosystems, which nature took millions of years to establish and maintain, is in question. For ecological factors, there are no barriers, national or geographical. The polluted air crosses into other countries. The border security forces or coastal guards cannot check its entry. It is common knowledge that the oceans are not static. The contaminated waters of an ocean can mix freely with those of others, thereby passing on the buck of pollution. It has long been known that polluted water resources were among the most dangerous of disease carriers. Typhoid fever is one of the epidemic diseases that has been traced directly to the domestic water supply.

Pollution is a problem-child of industrialization and overpopulation. The population increase has a direct relationship to pollution. Greater concentrations of people coupled with increased industrialization, contribute to pollution. The more the number of vehicles on the road, the more infested is the atmosphere of a city. The carbon monoxide content has become higher. In the last hundred years, man has consumed 240,000 million tons of oxygen by burning the fossil fuel and let out 360,999 million tons of carbon dioxide into the atmosphere.

The rate of oxygen consumption has lagged behind its replenishment. By A.D. 2000, the consequences shall be dreadful. Man is now taking in carbon-soot, fumes of sulphur and nitric vapours along with the air he inhales for respiration. According to a study by NEERI (National Environment Engineering Research Institute), the sulphur dioxide level is 0.223 microgramme for each cubic metre of air in Delhi and 0.71 in Calcutta. In the U.S.A., the level is not permitted to exceed 0.1 microgramme. According to another estimate, 600,000 tons of antimony, 800,000 tons of nickel, 1000,000 tons of cobalt and about a million tons of other poisonous substances have been thrown into the atmosphere by man since the beginning of this century. So now, it is not merely air that we are inhaling. All these things are entering our lungs. This is in addition to our normal quota of millions of bacteria, viruses and fungal spores.

The wastes from the industrial plants are being either dumped on land, rendering it more barren and beyond any measure of reclamation, or are poured into the rivers and streams and ultimately into the seas. The sea is now becoming a dustbin, for wastes discharged, directly or indirectly, into the atmosphere or into the rivers, flow into the sea. Because of this, the tranquility of the seas has been disturbed. The sea plants, mostly algae, are dying and fish and other animals are being asphyxiated.

The disposal of sewage and industrial waste is an important problem of water conservation, especially in the metropolitan districts. Although flowing water exposed to the sunlight and air tends to purify itself, the problem of pollution has become more complex as domestic and industrial uses have been increasing

in relation to the total volume of water. Many processes have been devised to remove undesirable and dangerous substances from water that

is unsafe in the untreated state. A generalized plan involved in these processes is given in Fig. 1.

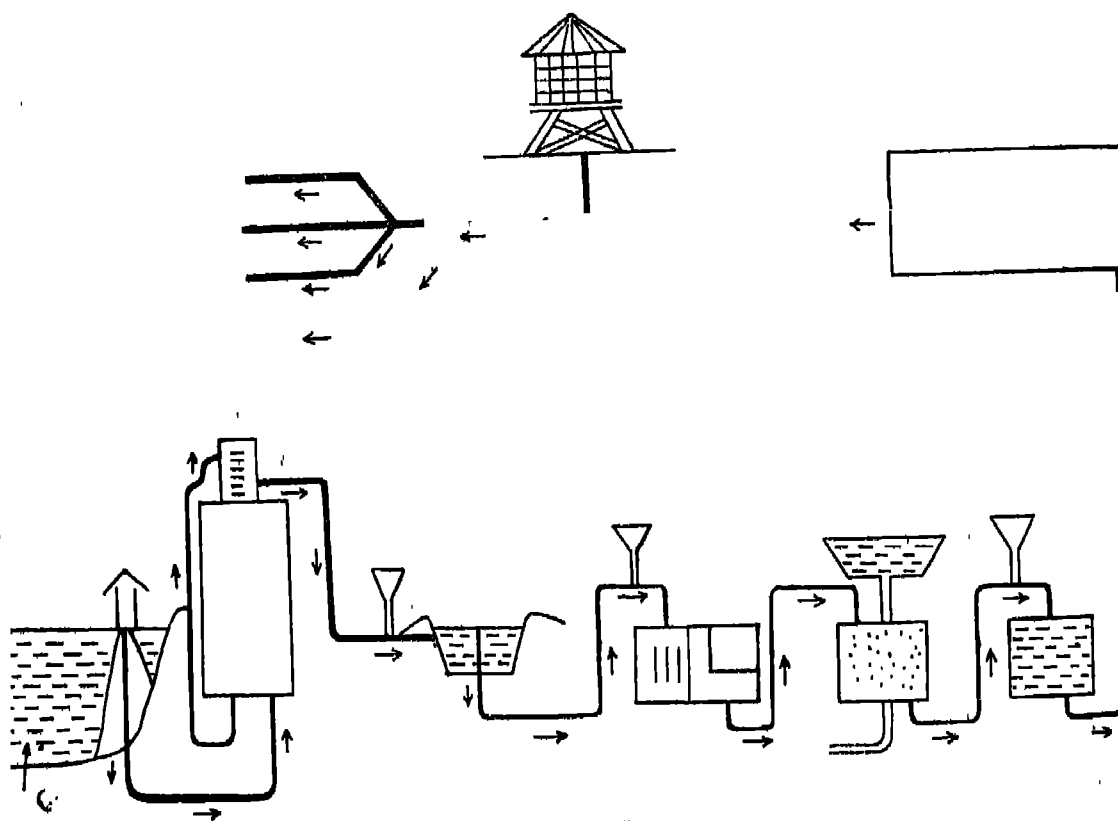


FIG. 1

Most of the productive fisheries of the world are concentrated in shallow waters adjacent to land masses, the very areas which receive the maximum amount of waste. Many a time such discharges have led to tragedies. In a Bombay study, the fish were found containing mercury in their bodies, between 500-600 nanogrammes per gram of their flesh.

The flora and fauna of the seas, particularly in the coastal areas, have fallen an easy prey to anoxia. Not merely from the point of view of food, but more significantly in the context of oxygen, this may prove disastrous one day. The sea around any country is the richest source of oxygen for it. When organic pollutants, mainly proteins, fats, soaps, carbohydrates, oil, tar, dyes and synthetic detergents decompose, they make demands upon the dissolved oxygen supply in the water. Many of the pollutants that deplete the oxygen supply are also rich sources of nitrogen and phosphorus. These nutrients cause certain types of plants and animal life to flourish widely. The whole process, wherein the waters become rich in dissolved nutrients and low in oxygen, sets in motion an aging process, *eutrophication*. In nature, a similar aging process occurs, but at a far slower pace.

According to a survey, the U.S.A. imports 65 per cent of its oxygen from the surrounding oceans. With pollution, we are losing the richest source of food and oxygen.

The reckless and unplanned nuclear blasts pose a potential threat to mankind. The radioactive fallout affects even the babies in the womb. The horror of such explosions in Hiroshima and Nagasaki is still, after many generations, writ large on the faces of the residents of these cities. Mr. Kurt Waldheim, the Secretary-General of UN, while addressing the Human Environment Conference in Stockholm,

considered the nuclear tests and chemical warfare responsible for the environmental crisis.

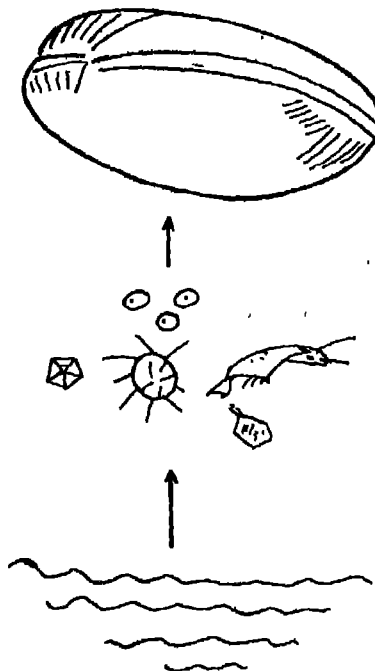
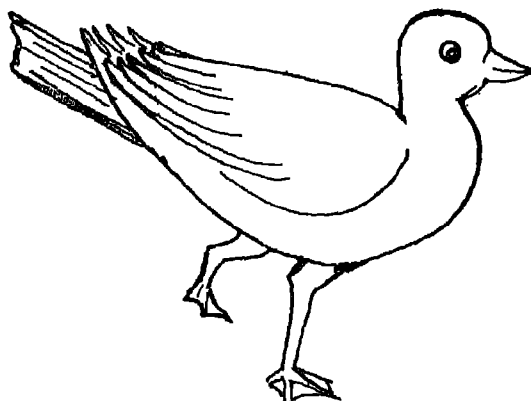


FIG. 2.

An illegitimate offspring of the increase in the yield of crops has been the extensive use of DDT and certain other insecticides, increasing the pollution hazards. For example, DDT is not broken down naturally, so it accumulates in the food chain. It is of interest that the water had only 0.00005 ppm of DDT residue, while birds at the top of the food chain had residues about a million times greater as shown in Fig. 2 (Woodwell, *et al.*, 1967). This is termed *Biological Magnification*.

In 1966, Soren Jensen of Sweden found out another group of chemical pollutants—PCBs (poly-chlorinated biphenyls)—as the cause of death of sea-birds. In 1968, in Japan, PCB-poisoning was diagnosed in 15,000 victims, who had used contaminated rice oil. A few years ago, a heavy mortality of sea-birds in the 'fish sea' was traced to high concentrations of PCBs in their bodies.

Now the question arises: where does the solution to this menacing problem lie?

The literature pertaining to the crisis is piling up. In many countries, commissions or committees have been set up. From time to time, conferences have been held, at UN level, to awaken the people and to make them conscious of the problem. In some countries, legislations have been enacted to restrict the pollution. The National Air Quality Act of 1970 has restricted the use of motor vehicles, power plants and planes in certain parts of the U.S.A.

D.D.T. has been banned in many European and North American countries. The Stockholm Conference or the Second International Clean Air Congress held in Washington had seriously studied the different aspects of the pollution problem and certain practical measures have been suggested. For example, one of the actions of the Stockholm Conference on Human Environment (1972)

has been the establishment of the International Centre for Monitoring Pollution, in London. The UN Scientific Committee on the Problems of the Environment (SCOPE) has allotted a fund of one million dollars for its London centre. Under the aegis of SCOPE, seven projects, which need urgent attention, are being studied. One of the projects involves the sampling of the present state of environment, detecting changes and checking the effects of control actions. It shall be an endeavour of the Centre to find out what is needed to keep the environment healthy, to develop ways of looking at the environment as a whole. The emphasis of the study shall be more in the case of developing countries.

Recently (in June 1976), another United Nations conference—HABITAT—on human settlements was organized in Vancouver. It has sounded a worldwide alarm that many of the world's urban agglomerations are in a state of crisis. This is particularly more apparent in case of developing countries. Through public exposure HABITAT has tried to raise the consciousness of the public and the governments alike.

Gradually, the emphasis on better understanding of ecology is growing up. The detailed studies and the knowledge about the ecosystems is contributing much towards the understanding and solving of pollution problems.

Mills, mines, chemical industries, tanneries, and other industrial concerns often have waste water, containing highly toxic or noxious chemicals which can render large streams unfit for any further use. The problem about the tipping of poisonous industrial waste products, liquid and solid, on the land or into the sea, is being tackled in some countries. Some pulp mills, which have excessively

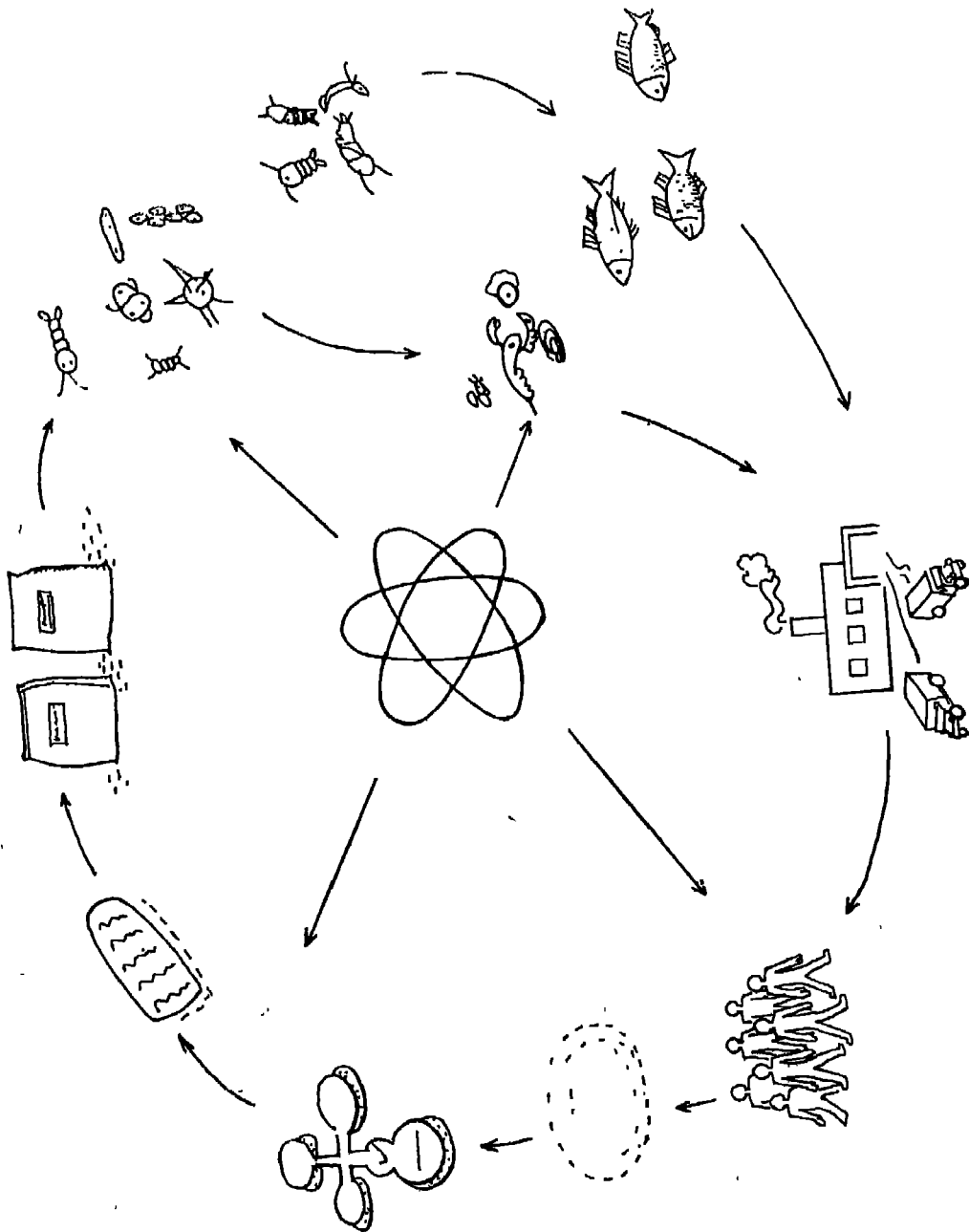


Fig. 3

toxic wastes, have devised recirculating systems whereby the waste water is processed, the chemicals reclaimed for further use, and the water rendered pure enough for further use. Such expensive systems are only useful at places where water supplies are limited.

An important aspect of pollution control may be biological control or the natural method. Here the work can be better envisaged and undertaken in collaboration with nature and not by throwing a challenge to her. The process of adaptation is there to help and protect us. All living organisms, including man, possess the inherent genetic potential to adapt to changing environment vis-a-vis the pollutants.

Mihursky has presented a schematic diagram to illustrate the possibilities of using two troublesome water-pollution waste products: the waste heat from the electric power plants and the nutrients from organic wastes (Fig. 3).

A study (1975), by Dr. John S. Gray of Leeds University on *Cristigera* (a small marine species), has shown that these animals become predisposed physiologically to tolerate pollutants.

But still, the process of adaptation, slow as it is, is no alternative to the adoption of certain concrete measures to face, check and fight the menace of pollution.

We should not simply sit and wait. □

# The Capture and Care of Snakes

B. D. SHARMA and TEJ SHARMA

*Deptt. of Zoology,*

*G. G. M. Science College, Jammu Tawi*

SNAKES are generally feared. A great many people who do not know about the economic values of snakes and the scientific facts about them detest these fascinating creatures of nature. There is nothing to the common belief that every snake is poisonous. Out of the over 2,500 known species of snakes, only 218 are poisonous. And in India only 52 species are poisonous out of 216 known varieties. In fact, snakes are highly useful to man. They check the numbers of rats and mice—rodents which destroy food crops.

In India and many other countries, snake charmers and professional snake catchers supply snakes to serpentaria in zoos and venom research laboratories. The Miami Serpentarium (USA), the Bangkok Snake Garden and several other serpentaria all over the world have teams of snake catchers. In India, the Haffekine Institute, Bombay, and the Madras Snake Park have rich and varied collections of Indian snakes. The recently established Nehru Snake Park in Tamil Nadu has a good collection of earth snakes (Uropeltidae).

## *Where to find snakes*

Most snakes are active in the early hours of

the day and in the evening. They are seen mostly in the monsoon. The habitats of snakes are varied. The Indian freshwater snakes, which are all non-poisonous, are found in ponds, pools and puddles, rivers and lakes. The marine species are extremely poisonous. Land (terrestrial) snakes are found in bushes, rocky crevices or ledges, hollows of trees etc. It is not uncommon to see a snake lurking in fields of paddy or maize, in gardens and in the grass.

## *The collection kit*

Tools for catching snakes are many—gloves, nooses, bags, cages (terrarium), snake hooks, etc. The snake hook, made of a stick (normally bamboo) with a 'L' shaped stiff wire stuck to its end, is used to poke snakes hiding in corners and rock crevices. The bag, made of muslin with double stitching on three sides, is wide open at one end. The bag is the size of a pillow cover, with a knot at the open end.

Snakes are very agile and cautious. A careful search and attention are essential for catching them. On no account should they be disturbed. The approach should be dead slow. A local snake catcher with all his experience can prove useful to an amateur who wishes to make a rich collection.

Techniques of catching snakes, however, vary with the nature of the species. It is, therefore, essential to know the variety of the snake before trying to catch it. Sometimes tools cannot be used, as when you encounter a running grass snake. On humid nights snakes are seen along roadsides and in summer they are to be seen basking in open fields. In catching non-poisonous freshwater snakes (*Cerberus*, *Giardia*, *Natrix* etc.) and land snakes (*Amblystoma* spp. royal snake, rat snake) the following



methods can be used, depending upon where they are found.

1. Hold the snake by the tail and put it in the bag.
2. Grip the snake gently and bag it.
3. Keep a stick lightly pressed horizontally on the neck and put it finally in the bag, net or terrarium.

While handling any kind of snake, care should be taken not to cause any injury to its ribs. Dislocation of the vertebrae is common. It has been observed that injured snakes refuse to eat and even die of starvation. The easiest way of gripping a snake by the neck without injuring it is to catch it by the tail. It should then be held between the legs and eased through slowly till the neck is gripped delicately and firmly.

While catching poisonous snakes like cobras and vipers, great care is necessary. It is not enough to follow the standard catching techniques and should be attempted only by seasoned catchers. However, the following points should be borne in mind.

1. Handling poisonous snakes with bare

hands should be avoided.

2. Ordinarily, snake hooks and bags are used for the small, sometimes even the large varieties. This technique is the best, and is used by many professional snake catchers.

3. Large snakes like cobras, kraits, and Russell's vipers, do not like pressure on the head or neck and cannot be held down with sticks. The stick should be kept in a horizontal position firmly and pressure should be released carefully at its working end. While bagging the snake, extreme care should be taken. Rashness at this critical moment can be dangerous. Another important fact to remember while bagging or caging poisonous snakes like kraits, vipers, and cobras in a terrarium, is their cannibalistic habit. The non-poisonous varieties are also cannibalistic to a limited extent. Therefore, both poisonous and non-poisonous snakes must be kept apart. This goes for the smaller snakes as well. Though not many people in our country collect snakes, it is widely practised abroad.

Though catching snakes is a tricky and often a dangerous job, it has its rewards and can make a delightful hobby. □

# Bionics

M. A. CHANDRASHEKAR

*Lecturer in Physics,  
Regional College of Education, Bhubaneswar*

Our new school curriculum emphasizes the environmental approach to the teaching of science. One studies both living things and inorganic matter in the environment to see how best the knowledge so gained can be applied in the various branches of science and technology.

Incorporating this idea, in 1960, study of the new science of bionics began. Bionics studies living creatures, and deals with the simulation of their behaviour either mechanically or electrically for various engineering operations. The following examples will show how the study of bionics has helped in various engineering fields.

The mosquito, by vibrating its wings, produces a sound which cuts through any sound made by man or from any other source, and still conveys a message to another mosquito 45 metres away. This phenomenon is studied in order to increase the efficiency of our telecommunications system, which is hampered by the noises produced by electrical disturbances in the atmosphere.

The bat is a very peculiar volant animal possessing a pair of leathery wings which are especially modified for flying. It can fly in a dark room with dozens of stretched wires without touching a single wire. This is possible

because it sends out short wave-length, high pitched sounds beyond the hearing capacity of man. The reflection of this sound from the objects around it enable the bat to steer its way. This in-built mechanism of the bat has been imitated in what is known as 'Sound Navigation and Ranging' (Sonar). Sonar is being used in measuring ocean depths, locating underwater objects like sunken ships, submarines etc. It is also used in ocean navigation. However, it has been found that the bat's sonar is far more efficient than the device designed by man.

The frog is another example. It lives on insects and its eyes instantly spot a moving fly within reach of its tongue. But if there are dead insects around, it will never recognise their presence. The frog's eye is being studied for possible application of this principle in monitoring and controlling air traffic at the major airports.

Apart from these examples, the peculiar reactions of some animals to sounds and smells is also utilized for developing useful instruments.

The sense of smell may seem to be less important for man than it is for animals. But it is not really so. Food is tasteless when the nose is blocked by a bad cold. Drinking water with a bad odour or sitting in a closed room is unpleasant. However, for animals, odour is still more important. Many male creatures find their way to their mates by following the smell given out by the females. Based on this idea, a mechanical apparatus for the detection of smell has been developed. Alcoholics and drivers are subjected to the mechanical nose test to see whether they are drunk. The artificial nose can also detect poisonous vapours

present even in small quantities. Control of odour is important for our large perfume, tobacco and deodorant industries. Odour also affects our lives in many subtle ways of which we are not aware. These researches should make it possible to analyse in detail the complex flavours in our food and drink, and to get rid of obnoxious odours.

Mechanical ears have been developed to detect enemy sonar, based on the uncanny directional hearing ability of owls. The owl has very sensitive ears which can detect the direction of a sound. This enables it to pounce on its prey without actually seeing it.

These mechanisms are electrical. The sense organs are instruments similar to a microphone, a phonograph or a camera. External impulses are detected and transmitted to the brain in the form of electrical impulses. In this process one form of energy is converted into another form of energy. After these impulses are processed in the brain, it sends back its reaction in the form of impulses

for execution by the different organs of the body. The human eye and ear are very sensitive and respond to energy as low as a billionth of an erg. With the advancement of electronics a lot more can be copied from nature for the benefit of man.

Now for a few examples which are not electrical in nature. The seabird's wings serve as a model for constructing airplane wings with unique stability. A mechanical gill similar to the breathing organ of a fish for extracting oxygen from water and the release of carbon-dioxide is being developed for use in submarines. Another example is that of honey bees. These bees fly several miles for the collection of nectar and pollen and return to their hives without any difficulty. This is possible because they fly in a particular direction keeping the sun's rays as points of reference (polarized light). This technique can be used for regrouping armed forces in a battlefield. By observing one's surrounding keenly, one can come up with many more observations and discover principles which can be effectively used. □

# Secondary Education in Switzerland

S.C. JAIN

*National Institute of Education, New Delhi*

SWITZERLAND has one of the best educational systems in the world. It is planned to suit the diverse needs of the country. Switzerland does not have a ministry of education. Although the country is very small, there is great diversity in teaching systems and curricula. The Education Department of Switzerland has established two coordinating bodies—the Committee for Inter cantonal Coordination of Educational Systems, backed by a group of pedagogical experts, and the Committee on Secondary Education.

The responsibility for organisation and supervision of schools is the State's. The Swiss confederation has framed some rules and regulations which are followed in the schools.

Physical education for boys is regulated by a federal ordinance based on the military legislation of the country. The Constitution has legislation on measures designed to combat the spread of infectious diseases. The Swiss National Science Foundation looks after scientific and technical research in the country.

The students who do not wish to join a course of general instruction or a course of specialized study (75% approx.) must follow a part-time course (1½ to 4 years) of non-professional instruction. This course includes basic accountancy, civics, and in rural areas—ele-

ments of agriculture for boys and domestic science for girls, besides the pupil's mother tongue.

The professional courses are in the form of an apprenticeship. They are conducted in commercial colleges, trade colleges and technical colleges. Some of the senior secondary schools train teachers for primary schools. The pupils enter secondary schools (*ecole normale*) at the age of 15 or 16 and receive a general or professional training for a period of four to five years. In some cases this training is given at the university after secondary school.

## *Secondary Education*

There are two types of general secondary education in Switzerland. The shorter course of two to three years, is generally for girls. It helps in broadening their general knowledge and outlook and offers a bridge between the end of obligatory schooling and entrance to the professional schools. The nursery training colleges are an example of professional schools. The minimum entrance age for such schools is 17 to 18 years. The longer form of 4-5 years leads to a certificate of educational maturity, qualifying the pupil for university entrance. Seats at the universities are limited.

There are three general types of certificates awarded at the federal level (A) Latin/Greek (B) Latin/modern languages and (C) mathematics/science.

After completing obligatory schooling, the student may carry on his studies either with the aim of preparing for university entrance, or for beginning his professional training in a trade school. He may also follow the complementary courses of non-professional training.

### *General schooling*

Most of the schools allow the pupil to broaden his general knowledge without continuing studies at a higher level. This may serve as the grounding for professional training. The curricula are divided into optional and obligatory subjects, which permit the pupils to acquire training in the profession they choose to follow.

Another type of general secondary education is provided by senior secondary schools or colleges, which prepare the pupil for university entrance.

The certificate curriculum includes Latin and Greek, Certificate B includes Latin. The third language in the curriculum is a national language (French, German, Italian or English). Certificate C is science-based and includes descriptive geometry and a national language.

The examinations are conducted in the following subjects for all types of certificates (A, B and C)

1. Mother tongue (French, German or Italian)
2. Second language (French, German or Italian)
3. History
4. Geography
5. Mathematics
6. Physics
7. Chemistry
8. Natural sciences

Besides this Federal Certificate of Maturity, there are two other recognized certificates—the Certificate of Maturity in Commerce and the Certificate of Maturity in Modern Commercial Language. The pupils with these certificates can also join the university faculties of arts, political science, national and social

economy and natural sciences.

### *Training for a trade*

Training in a trade, in some cases, is provided without reference to their disciplines. In other cases it is coupled with workshop courses. In still other cases, training in certain trades can only be obtained through training schools. The pupil may start learning a trade after he has left the elementary school. He may either join a trade college, or a commercial or administrative organization.

### *Apprenticeships*

Apprenticeships are offered in industrial and administrative organizations, in the private or public sector. An apprentice may simultaneously attend a training course. He receives a certificate treated on par with those acquired at other schools.

The training, consisting of four to eight lessons a week, is provided in a complementary school. The pupils in complementary schools are grouped according to their professional aspirations. If this is not possible students are put together in the same class. The State makes sure of uniformity and efficiency of instruction by directives to the various industrial, commercial and trade schools and by instituting normal teaching curricula.

### *The Atelier-School and the Trade School*

In these establishments the training is confined exclusively to the school curriculum and the students are offered theoretical instruction. There are some schools which offer specialized training. Certain professional associations also contribute to training schemes either by instituting special courses of their own or by working in conjunction with the trade schools. Other associations have instituted 'pre-professional' training courses where an

opportunity is provided to the apprentices to familiarize themselves with the tools of their trade.

These courses may be attended immediately after the last year of formal instruction at the primary level.

The trade schools are quite frequently organized by professional associations. There are cheese making schools, embroidery schools, druggist schools etc. Again some of the schools have a system which combines practical training via apprenticeship with theoretical training. This theoretical training may take the form of an introduction to a particular trade.

The commercial and administrative schools prepare young people for an apprenticeship with the post office or the railways. Among the secondary trade schools, some prepare their pupils for studies at a university.

The senior commercial schools offer the pupil a three to four years' course, starting after obligatory schooling, which finally leads to the certificate of maturity in commerce. It qualifies the holder to join the economics and social science faculties at a university.

The senior technical schools normally require a completed apprenticeship as entrance qualification. The pupils, at the age of 19 or 20, embark on a three-year course of theoretical and practical instruction. Those who join a senior technical school immediately after the primary level, follow a five-year course. The Technical Engineer diploma is awarded by these schools. The schools are, by and large, equivalent to the French "*Arts Metiers*" engineering schools.

The *ecoles normales* that prepare primary school teachers, are secondary institutions which have pupils of 15 to 16 years. These schools offer an extensive general education and appropriate professional training for four to five years.

It is possible to extend this training by going on to a university.

Secondary school teachers, on the other hand, are generally trained at university level.

The secondary school teacher's diploma is an academic qualification. In many cases, these teachers have also completed a university degree course or graduated as doctors of philosophy or licencies. The master's certificate is a proof of occupational and administrative perfection.

### *Complementary Training*

There are some students who do not wish to continue with their schooling after the obligatory years. The minimum school-leaving age is 14 years. The minimum age for starting out as an apprentice is 15 years. In some cases, a child may spend this time in another part of the country to familiarize himself with the language of that region. However, many boys and girls immediately start working. They start earning immediately after leaving school and may not be inclined to give up this newly-won financial independence. It has, therefore, been found necessary to make complementary schooling obligatory for children who do not continue in a secondary school or join an apprenticeship programme after the obligatory school years. These courses are termed 'non-directed', in order to distinguish them from the specific orientation of the apprenticeship courses. In rural areas, something between a quarter and one-third of the curriculum may be given over to agricultural training. In the complementary courses for young girls, there is an emphasis on domestic science. In the cities, on the other hand, these complementary courses are more general in character. They cover a period of one to four years. Languages, arithmetic, simple book-keeping, civics and

technical instruction are included in the syllabus for these schools. In certain cases, industries offer similar courses.

### *Special School*

The 'special schools' are for mentally or physically handicapped children. There are special classes for children who, for some reason or other, are not in a position to follow a normal course of instruction. Children who find it difficult to keep up with their studies, even after having repeated a year, are put into these special classes. Every effort is made to separate children of normal intelligence from retarded children. These special classes may be taken in a public school or a private institution. The teachers who teach in the special

schools hold diplomas in remedial pedagogy.

### *Auxiliary Teaching*

The children from poor families are given medical aid, pedagogical training, and a chance to earn while they learn. Since each child must be given the opportunity of getting the best possible education, financial aid is frequently granted in the form of free instructional material, travel allowances, food allowances, organized supervision of study, scholarships, etc.

Secondary education in Switzerland reflects, perhaps more than primary education, the unity and flexibility of the Swiss educational system. □

## Magic Squares

*This is in continuation of A. Venkatacharlu's article published in School Science, June 1976, issue.*

### *Filling a 4-house-square*

We may choose any of the following series.

1. It may be any 16 consecutive natural numbers e.g. 5,6, .....20.

2. It may be 16 consecutive numbers of an arithmetical series with a common difference e.g. 1,3,5, .....31.

3. It may be 4 sets of 4 consecutive numbers of an arithmetical series separated by equal intervals e.g. 1,3,5,7; 13,15,17,19; 25,27,29,31; 37,39, 41,43.

4. It may be 2 sets of 8 consecutive numbers of a series separated by an interval of any length e.g. 1,3,5,...15; 21,23,25.....35.

5. It may be 4 sets of 4 consecutive numbers of 4 different series, the C.D. being the same in all and the difference between the first numbers of the 1st and 2nd sets being equal to the difference between the 1st numbers of the 3rd and 4th sets. The last of the 2nd and the 1st of the 3rd may be separated by any length.

e.g. 1,3,5,7; 10,12,14,16; 50,52,54,56; 59,61,63,65

6. It may be 4 sets of 4 consecutive numbers of 4 different series, the C.D. being the same in all and the 1st numbers of the 4 sets forming a different series with a different C.D. e.g. 1,3,5,7; 10,12,14,16; 19,21,23,25; 28,30,32,34. We have already given numbers to the houses in a 4-house-square. The 1st method has been followed in the forthcoming 4-house-squares. While filling the square follow the order given by these numbers.

### *How to fill up a 4-house-square*

Enter the 1st, the 4th, the 13th and 16th numbers in their respective corner houses; the 6th, 7th, 10th and 11th numbers in their respective central houses. Enter the 2nd and 3rd numbers in the 15th and 14th houses, the 5th and 9th numbers in the 12th and 8th houses, the 8th and 12th numbers in the 9th and 5th houses and the 14th and 15th numbers in the 3rd and 2nd houses. (With sufficient practice this becomes automatic)

### *4-house-squares filled up with the series given above:*

(1) Series (1) given above, starting from the left hand top corner and proceeding to the right (2) Series 2 given above, starting from the right hand top corner and proceeding to the left (3) Series 3 given above. Starting from the right bottom corner and proceeding to the left.

(4) Series 4 and starting the left bottom corner and proceeding upwards (6) Series 6 and starting from the left bottom corner and proceeding to the right. Series 5 given in





*Something Special*

Suppose you want to engrave the year of construction of a building in the 2nd and 3rd houses taken together of a 4-house-square (as is seen in one building in Greece) and put it in a prominent place, here is the method.

Let us take the year 1976. We often read it as nineteen seventy-six. 19 and 76 are two far from each other to belong to one series. Therefore 19 must belong to one series of 8 numbers and 76 to another of 8 numbers, both the series being with the same C.D. Here are 4 ways of doing it with 1 as C.D.

1. 26, 25.....19; 79, 78.....72
2. 12, 13.....18, 19; 73,.....80
3. 15, 16..... 22; 76,.....83
4. 23, 22.....16; 76, 75 .....69

(1)

75	19	76	26
24	78	21	73
25	77	20	74
72	22	79	23

*descending order*

(2)

77	19	76	12
14	74	17	79
13	75	18	78
80	16	73	15

*ascending order*

(3)

83	19	76	18
16	78	21	81
17	77	20	82
80	22	79	15

*ascending order*

(4)

69	19	76	20
22	74	17	71
21	75	18	70
72	16	73	23

*descending series*

In the above the starting point and the direction are shown by arrows—whether the series is of ascending order or descending order can easily be found. Only natural numbers are used. With a C.D. of 2 only one series in the ascending order is possible. It is 5, 7, 9, 11, 15, 17, 19; 70, 72, 74, 76, 78, 80, 82, 84. It must be started from right hand top corner and proceed downwards.

If a series is of descending order any C.D. can be used. Many series are possible. Only 3 are given below.

- (1) 33, 31, 29, 27, 25, 23, 21, 19; 82, 80, 78, 76, 74, 72, 70, 68

C.D. is 2

- (2) 40, 37, .....19; 85, 82, 79, .....64

C.D. is 3

(3) 47,43,39.....19; 88,84.....64,60

C.D. is 4

4th house is the starting point for these and we should proceed downwards.

Using the principle involved in series 5 given before we can have many other series. Only one is given here:

14,13,12,11; 22,21,20,19; 79,78,77,76; 87,86,85,  
84.

87	19	76	14
12	78	21	85
13	77	20	86
84	22	70	11

### *Something interesting*

At the end of Part I, under a similar heading, we saw some interesting things. Trace similar ones in all the above 4-house-squares.

*Filling up a magic square of houses each way being a multiple of four.*

Let us take a 12-house-square.

Pair the 1st and last i.e. 1 and 144, the second and the last but one i.e. 2 and 143 and so on. We will have 72 pairs.

Divide the 12-house-sq. into nine 4-house-squares. Fill up any one of these 4-house-squares with the first 8 pairs taking the numbers in the ascending order e.g. 1,2,3,4,5,6,7,8, 137, 138, 139, 140, 141, 142, 143,144. They can be taken in the descending order also

1	143	142	4
140	6	7	137
138	138	139	5
141	3	2	144

Since each square gives the same total one square may be filled up in the ascending order and another in the descending order as one likes.

# MAGIC SQUARES

51

1	143	142	4	9	135	134	12	17	127	126	20
140	6	7	137	132	14	15	129	124	22	23	121
8	138	139	5	16	130	131	13	24	122	123	21
141	3	2	144	133	11	10	136	125	19	18	128
25	119	118	28	33	111	110	36	41	103	102	44
116	30	31	113	108	38	39	105	100	46	47	97
32	114	115	29	40	106	107	37	48	98	99	45
117	27	26	120	109	35	34	112	101	43	42	104
49	95	94	52	57	87	86	60	65	79	78	68
92	54	55	89	84	62	63	81	76	70	71	73
56	90	91	53	64	82	83	61	72	74	75	69
93	51	50	96	85	59	58	88	77	67	66	80

Sum=870

Sum in each 4-house-square=290

All are filled up in ascending order only.



# Science News

---

## INDIA AND INDUSTRY

---

### Chemicals in development

THE chemical industry occupies a very important position in the national economy of our country. It plays a key role in the country's defence capability and because of its inter-relationship with other industries, it provides a flourishing base for industrial development. Chemicals of one type or the other are required in almost all the industries like paper, sugar, textiles, pharmaceuticals and so on. Besides, chemical products are substituting other materials in practically every sector of economy and are servicing almost every industry in some way or the other.

Chemicals have made a very significant contribution towards augmenting food production by supplying fertilisers and pesticides. They have also helped in conservation of water resources and providing new fibres to substitute cotton, and in developing improved construction materials to substitute scarce metals.

The total investment in the chemical industry of our country has risen from about Rs. 3,040 million in 1961 to over Rs. 22,000

million at present. The value of production has risen from a mere Rs. 1, 200 million in 1955 to well over Rs. 20,000 million.

### *Inorganic chemicals: Sulphuric acid from pyrites*

Most of the sulphuric acid produced in India is based upon imported sulphur, there being no known source of elemental sulphur in the country. In order to reduce the country's dependence on imported sulphur for the manufacture of sulphuric acid, efforts have been made in the recent past to use raw materials other than elemental sulphur. As a result of the efforts made so far, production of sulphuric acid has been established from pyrites mined at Amjor (Bihar) and from sulphurous gases of non-ferrous metal plants like zinc smelters at Alwaye and Udaipur and Copper Smelters at Ghatsila and Khetri.

Sulphuric acid is required in the production of fertilisers, rayon, bicromates, steel aluminium sulphate etc. With the planned production of the above items, the production of sulphuric acid in India has gone up over four times from 3,53,943 tonnes in 1950 to 14,45,000 in 1975. There are 65 units in production in various parts of the country. Most of the plant and equipment required for the manufacture of sulphuric acid are available from indigenous sources.

### *Hydrochloric acid*

Hydrochloric acid is a by-product of caustic soda. The current estimated production of hydrochloric acid is 1,50,000 tonnes which is likely to go up to 2,50,000 tonnes by 1978-79. Hydrochloric Acid, as a cleansing agent is largely required in paper, textile, printing,

aluminium, nickel polishing, industries. It is also used in industries like oil-drilling, pickling, calcium chloride and drugs, etc.

### *Nitric acid*

Nitric Acid is a key input in the manufacture of basic organic chemicals, fertilizers, explosives and aromatics. FCI is the largest producer of nitric acid. The production of nitric acid has shown a steady increase from 3,72,800 tonnes in 1973 to 4, 57, 400 in 1975.

### *Caustic soda*

Caustic soda is a versatile basic heavy inorganic chemical. Aluminium, rayon, viscose fibre, soap, paper and pulp industries are the major consumer of this chemical. With the growth of the user industries, the production has also grown in a planned way. Production of caustic soda in this country was started for the first time in 1941 when two units of 5 tonnes per day capacity were established. From this modest beginning the industry has made considerable progress reaching a total installed capacity of 6,03, 000 tonnes and the number of units has gone up to 31. Two units—one substantial expansion of 100 tonnes per day in the State of Karnataka—were commissioned into production during the year 1975. The unit of M/s Gujarat Alkalis and Chemicals Ltd. in the State of Gujarat with 115 tonnes per day capacity will go into production during the current year.

### *Soda ash*

Soda ash is an important heavy inorganic chemical used as a raw material in the manufacture of glass, glassware, sodium silicate, paper

and pulp, textiles and bicromates etc. It is also used as a washing material by dhobies and in households. With a modest beginning at Dharangadhra in the State of Gujarat in the year 1923, the industry has now a total capacity of 63 million tonnes distributed among four factories.

### *Dyes and dye intermediates*

At present, all the main types of dye stuffs are being produced in the country catering to the needs of the industries like textiles, leather, printing ink, paper, paints, plastic, coir etc. The product range covers a wide area; acid dyes, basic dyes, direct dyes, disperse dye, fast colour basis, naphthols, mordant dyes, food colours, optical whitening agents, organic pigments, sulphur dyes, vat dyes and reactive dyes.

The production of dye-stuffs in the organised sector which was 674 tonnes in 1953 rose to 6,000 tonnes in 1960, 13,882 tonnes in 1970 and to 15,000 tonnes in 1975. The exports of dye-stuffs and intermediates are increasing.

### *Pesticides*

Pesticides industry has been assigned a vital role both in the crop protection and health programmes. Production of pesticides during 1975 has shown sufficient improvement. It increased from 32,950 tonnes in 1974 to 34,849 tonnes in 1975.

### *Technology and research and development efforts*

The chemical industry is a highly technology-intensive industry and the need for increased research and development in this industry cannot be over-emphasised. The technologies involved are so sophisticated and so fast chan-

ging that the research and development efforts would have to be really intensive to enable the industry to keep abreast with the developments elsewhere in the world. Many progressive units of their own have contributed considerably to the growth of science and technology in the country. These efforts are, however, not adequate, and research and development effort of a very high magnitude is called for. It is in this context that the Government have introduced a research and development cess on all units so that the resources can be pooled and a major offensive launched to achieve a breakthrough in science and technology in this country. The success of the research and development efforts would no doubt result in lowering production costs of chemical industry.

#### *Pollution control*

Together with the development of the chemical industry. The Government are particularly anxious that the problems of pollution control should be firmly dealt with. The concern is not only about health hazards to workers in the chemical industry but also about the health hazards to the community arising from pollutions and effluents in the chemical industry. Towards this end, there are continuous consultations between the Government, industry and the workers. The public sector is now, as a matter of policy, taking steps to ensure that pollution control becomes an integral part of the project. Efforts are also being made to ensure that even in the projects already in operation, pollution and effluents level are brought down to the statutory limits.

---

#### DISCOVERIES AND INVENTIONS

---

### **Sunshine helps drive car**

An Israeli engineer has designed what he claims is the world's first solar-powered car, and predicts that in 10 years the country will be dotted with fuel stations where drivers will fill up on sunshine.

The small two-seater car looks appropriately from science fiction, with large panels containing nearly 600 solar cells covering the roof and bonnet. These cells convert the sun's energy into electricity and are connected by hundreds of coloured wires to eight batteries under the seats.

"The trick is to park the car in the sun rather than in the shade as you normally would," says the inventor, Professor Arye Braunstein, head of the power engineering department of Tel Aviv University.

His creation is ideal for countries such as Israel and other tropical countries with practically year-round sunshine. But he admits it would be of limited use in the cloudy parts of the world. With the charge and no sunlight, the car has a range of 60 km and if parked in the sun during the day an additional range of 20 km.

He hopes that in three years the vehicle's range will improve to 150 km as the efficiency of the cells improves and the car's body is redesigned to carry more cells. A 100 per cent solar-powered car is a simple matter even now. "You leave one set of batteries at home basking in the sun and drive around with a second set," he explains.

"When you come home in the evening you exchange the sets and leave the used batteries

to charge up again. This way you will be driving around only on sunshine”.

“In the future, say, in 10 years, we will have fuel stations where you will have sets of batteries available. You will just drive up and exchange your rundown set for a new one”.

The initial price is still high with the car and solar cell panels costing around \$4,200. “But in three years, with mass production, cheaper cells and dearer fuel, it will become competitive.”

### 3,000 year old seed sprouts

A seed estimated to be 3,000 years old has recently sprouted in a refrigerator where it was stored along with about 100 other seeds after they were discovered at an archaeological site in Japan.

Dr. Koichi Umemoto of Kyoto College of Pharmacy said he found the seeds in Fukuoka in south-western Japan in a mud stratum of the Jomon culture period of 3,000 years ago.

Discovery of the seed that sprouted would be significant if it could be confirmed to be a vegetable because “there are no records that vegetables grew or were grown in the Jomon period,” he said.

---

#### MAN AND ENVIRONMENT

---

### It may turn uncomfortably warm

Only in the last hundred years or so have detailed records been kept of temperature

fluctuations. Observations show that the average temperatures of the air at the earth's surface increased steadily up to the 1930s. After that the climate began to grow cooler and by the early 1970s the temperature had dropped on an average by 0.3 degrees C.

The current changes in climate are due to variations in the amount of solar radiation that penetrates the troposphere—the lower part of the atmosphere in which most observed climatic phenomena take place. These variations are themselves caused by changes in the transparency of the higher layer of the atmosphere, or stratosphere, which contains dust particles that disperse and absorb the sun's rays.

These particles find their way into the stratosphere largely as a result of volcanic eruptions. It was the absence of any major eruption in the 1920s and 1930s, that made the atmosphere more transparent and the climate warmer.

#### *The dustman cometh*

Today, however, man is competing successfully with volcanoes in filling the atmosphere with dust. Moreover, burning oil, coal and other fuels creates a good deal of carbonic acid gas. Part of this dissolves in the sea, but at least one-half remains in the atmosphere so that the concentration increases every year. This, too, leads to an increase in the average temperatures. If the carbonic acid gas content of the atmosphere were to double, something which might well happen in the next few decades, the average air temperature would rise by two to three degrees C.

Another factor contributing to climatic change is the production of power—now increasing at a rate of six per cent a year—which,



transformed into heat, further warms the atmosphere. In big cities, where power is generated in huge quantities, the temperature of the air is usually one to two degrees higher than in the surrounding countryside.

Since many modern cities are fast becoming concrete jungles, and since the microclimates of these affect the weather in neighbouring areas, the possibility of overheating the entire atmosphere is by no means to be excluded.

Moreover, profound changes in the climate could occur much earlier as a result of disturbed relationships between various elements in the complex system which determines weather.

### *Melting icecap*

Here is one possible scenario for climate change: because of rising temperatures, polar ice will gradually recede and areas of water thus freed would retain solar heat previously reflected off the ice. The thinckness of the ice layer that forms in winter would grow steadily thinner. This in turn would disturb the Arctic currents that flow towards lower latitudes, and possibly affect continental rainfall. For all we know, the deserts might begin to encroach on major agricultural regions.

Even a fractional change can have a significant effect on natural conditions. From the late 19th century up to the 1940s, the average temperature rose by 0.5 degree C. In the Arctic, the increase was several degrees higher, with the result that the area of ice was reduced by ten per cent and its thickness by about a quarter. Glaciers retreated all over the world, freeing new land for pastures and cultivation. Then the reverse trend began and it has been getting colder in recent years.

Why is this so if carbonic acid gas concentrations in the atmosphere and heat from the

surface of the earth are increasing? The answer is the growing amount of dust in the troposphere, working to cool down the weather.

Nevertheless, concentrations of carbonic acid gas and power production are likely to continue to grow. And in the coming century the additional heat thus produced may become comparable to the amount of energy received from the sun. On the other hand, the amount of dust in the atmosphere will probably be reduced as a result of antipollution campaigns. All in all, temperatures in the northern hemisphere will probably rise by 0.5 or one degree in the next 25 years and by several degrees by the middle of next century.

A significantly warmer climate would cause great difficulties and many countries would be obliged to change their agricultural and other economic activities that are dependent on weather.

To counteract such effects, a number of projects are now being examined by scientists. One involves changing atmospheric movements on a large scale. It has also been suggested that the dust content of the lower stratosphere could be increased significantly by burning tens of thousands of tons of sulphur a year and spreading it with the help of high altitude aircraft. This would reduce the intensity of solar radiation in the troposphere and air temperatures in the northern hemisphere would drop by several tenths of a degree. It would also increase rainfall in continental regions of the temperate zone.

### *Proceed with caution*

But this idea, and other proposals for large-scale changes, should be considered with great caution. Changes in the dust content of the

atmosphere could have complex and unexpected effects.

Is it wise to influence the climate? All things considered, it is. The first step would be to increase research in climatology.

Quite understandably, any project for influencing the climate can only be carried out on the basis of co-operation and agreement between countries. But such research should begin at once: changes in the weather induced by economic activity may become even more tangible in the next few decades and methods of preventing unfavourable fluctuations need to be worked out.

## **Wanted a full iceberg, not just the tip**

Saudi Arabia was considering its plan to tow icebergs. Over a distance of 8,000 km from the Antarctic to the Red Sea, to provide more water for the desert kingdom.

The initial voyage at snail's pace of one knot, could take from 6 to 12 months and cost about \$80 million.

It was contacted about a year ago by Saudi officials who wanted a fresh approach to their country's water shortage problems. Discussions are now in the final stage.

The engineers worked out the iceberg plan in coordination with the French polar experts and are confident that it will work. For the trial run, five ocean-going tugs, each driven by 20,000 horse-power engines, would travel to the Antarctic where special crews would pick out a suitable iceberg.

The ideal one would have a more or less rectangular shape to prevent tipping and

would weigh about 100 million tons with length about 1.6 km, breadth 800 metres, and height 700 metres, one-fortieth of which would be above water.

After the iceberg is selected, the experts will fix an 18-inch-thick special plastic cover over it, to protect it from the melting rays of the sun and the destructive force of waves and currents.

Special cables will then be rigged between the iceberg and the tugs and the trip will begin. But two problems remain. The first one is heat. Icebergs are rarely sighted beyond 40 degree latitude and it is not known for sure whether it will survive the torrid portion of the long trip.

The other is ocean depth. Even though the waters off the Saudi capital of Jeddah are 600 metres deep and could accommodate the iceberg, the straits of Bab al Mandeb connecting the Gulf of Aden with the Red Sea are about 100 metres deep.

## **Soot from power plant**

Two Delhi meteorologists, Dr. S. Padmanabhamurty and Mr. N. Gupta, have recently worked out that 69,864.3 kg of soot particles settle down in an area of 15 km round the Indraprastha thermal power plant in Delhi every year.

The meteorologists feel that the only step that could be taken immediately to reduce solid particles in the air would be to raise the height of the Indraprastha plant chimneys from 62 metres to 90 metres. This will help disperse dust over a wider area and thus avert concentration of fallout.

Their study is the first of its kind on the presence of solid particles suspended in the air-fly ash containing mainly sulphur and carbon. Earlier studies dealt with emission of grass like sulphur dioxide.

Another way of reducing particle deposits would be to provide for the maximum emission of smoke between 8 p.m. and 5 a.m. when the particles tend to remain airborne due to atmospheric pressure. There should be minimum emission between 4 p.m. and 8 p.m. when the particles settle down.

This is called the 'meteorological control' technique, scheduling the release of effluents into the atmosphere under favourable 'dispersion conditions' and restricting their release under unfavourable conditions.

Dr. Padmanabhamurty and Mr. Gupta urged the town planners and public health authorities to take note of these findings while formulating developmental programmes.

---

#### MAN FIGHTS DISEASES

---

### Diagnosing diabetes from the folds of the neck

Dr. A. V. Sabha Rao of Kerala has discovered a new physical "sign" for detecting diabetes. This diagnostic method does not require the patients blood or urine for analysis. It simply calls for an examination of the "creases" and "folds" on the back of the patient's neck.

This examination coupled with the observation of the growth pattern of hair on the nape of the neck would reveal if a person is diabetic or going to develop diabetes. The accuracy of this method is claimed to be about 90 per cent,

The discovery which is being followed up abroad would help physicians diagnose diabetes even before its onset by routine screening of all patients for the "neck sign". To look for the sign the patient holds his head upright while the doctor observes and feels the folds and creases on the back of the patient's neck.

Normally there are up to three creases each separated by the adjacent one by about an inch. The first crease which is the lowest of the three lies along the line that separates the neck from the trunk. Dr. Rao had discovered that in diabetic patients, there was a prominent, lumpy projection (or bulge) of the skin "between the first and the second creases." Furthermore, the growth of hair on this bulge is "sparse".

But in the case of non-diabetic, persons the skin projection is only "slight" and hair growth is uniform and normal. Easily identifiable neck sign is present in 90 per cent of the diabetic cases, irrespective of sex or size of the person. The neck sign is present in "obese, normal and lean patients—men or women".

Dr. Rao made the discovery after looking for the neck sign in 2,056 cases admitted in his clinic for various complaints including diabetes. Out of these, the neck sign was found positive in 112 cases. Subsequent urine and blood analysis of these positive cases showed that 98 of them were diabetic.

To further establish the usefulness of the neck sign "as an aid to diagnose diabetes", Dr. Rao examined the neck of 105 confirmed diabetic patients undergoing treatment. The sign was observed to be positive in 94 of them.

He had also got evidence that the skin bulge between the creases disappeared with treatment, suggesting a definite connexion between diabetes and the neck sign.

"The neck sign was only a test but was not the final answer to the diagnosis of diabetes," he said. Its usefulness was similar to that of the "neck rigidity test" which doctors employ for detecting meningitis.

## Live vaccine can cause polio

"The live vaccine has been the principal, if not the sole, cause of domestically arising cases of polio," Dr. Jonas Salk told a Senate hearing. "In other words . . . the risk of acquiring polio from the live virus vaccine is greater than from naturally occurring viruses." Dr. Jonas Salk, who first developed polio vaccine with dead virus, has warned the U. S. health officials that live vaccine could cause the disease.

Health officials were advised to switch to "killed" vaccine in their polio immunization programme because of this danger. Polio vaccine is given orally to millions of children in the U. S. A., usually by means of a drop on a sugar cube. "Dead" vaccine would have to be injected.

An earlier test aboard Viking-1 did not indicate the presence of organic compounds, which are the building blocks of life as we know it on earth.

The soil sample was dug up by the lander's robot arm in an apparent dry stream bed the scientists call "Bonneville Flats".

## *Mass Spectrometer*

It was deposited in the gas chromatograph mass spectrometer, which will take a reading of gases released after heat treatment. This is the same instrument that sniffs the Martian atmosphere for the presence of gases needed to support life.

Another continuing experiment aboard both the landers has failed to indicate the presence of life. This is the "chicken soup" experiment in which nutrients are placed in the soil to see if any biological specimens consume it. So far it has indicated only a chemical reaction between the nutrients and the soil.

## Organic matter not found in Viking tests

The Viking mission's chances of finding life on Mars were dealt a blow when the latest data from the Viking-2 showed no sign of organic material in Martian soil.

Life, as man knows it, is not possible without organics—tiny chains of carbon atoms—and neither of the Viking landers has found organic matter on Mars.

The director of the mission's science analysis said there was still the possibility of life on Mars but it was difficult to "explain no organics"

---

## MAN AND MARS

---

## Searching life on Mars

Three previous readings—two from Viking-I and one from Viking-2—indicated the presence of biological activity on the planet. But scientists said they needed to find organic compounds in the chemical analysis tests before they could conclude that life exists on the planet.

Scientists said Viking-2 would conduct further searches for organics—including digging under a Martian rock—but there was not much hope at the Jet Propulsion Laboratory that the elusive “building blocks of life” would be found.

The results reported were from the first test of the soil by Viking-2. A sample of soil was heated to 200 degrees F in the hope of vaporizing any simple organic compound that might be in the dirt.

### Similarity of soil at landing sites of two Vikings

An X-ray instrument on the Viking-2 Lander told scientists that the iron-rich topsoil at the Utopia landing site strikingly resembled that found around Viking-1 about 7,360 km away.

The preliminary test results, which indicated the soil is about 51 per cent iron, were “almost a xerox copy” of the findings Viking-1 sent to earth two months ago.

What made that particularly surprising was that the two regions Utopia and Viking-1’s home Chryse appeared to be rather different. Chryse features a pebbly surface. Utopia is rockier.

“This quite surprising homogeneity has a number of very interesting implications”, said Dr. Piestley Toulmin, director of the inorganic analysis.

The similarity of the soil make-up seems to confirm scientists’ belief that the nature of the soil was affected by ancient weather that swept over large portions of the planet.

What the results cannot tell the Mars watchers is whether the material below the

surface is similarly uniform around the planet.

The sample the Lander analysed was full of iron-laden clay, accounting in part for Mars’ reddish hue.

The analysis also showed there were large quantities of silicon, phosphorous, cobalt, manganese, aluminium and other elements.

---

## PHYSICS AND ASTROPHYSICS

---

### Astronomical tests of general relativity theory

THERE are three ways in which the validity of the postulates of Einstein’s Theory of General Relativity have been tested traditionally by astronomical means. One was the motion of Mercury’s perihelion which observations showed to be advancing about 43” per century more than what calculations based upon Newton’s gravitational theory led scientists to expect. This discrepancy was explained by involving the three fundamental principles of relativity of motion, the constancy of the speed of light and the famous mass energy equivalence relation  $E=mc^2$ . A second test involves measurement of the small deflection in rays of light from the stars by the sun’s gravitational attraction, observable only by comparison of photographs of a total solar eclipse and other of the same star field taken some six months later when the Sun is on the opposite side of the heavens. The third is the attenuation of the Sun’s light in overcoming that body’s own gravitational attraction, which exhibits itself in the form of a red shift of the Fraunhofer lines in the solar spectrum relative to the corresponding wavelengths produced in a laboratory spectrum. The quantitative amounts of the light deflection and solar red shifts are

not strictly in agreement with Einstein's predictions, but recent experiments in nuclear physics would now appear to have produced independent verification of the equivalence principle.

\*Synopsis of a lecture presented by E.G. Forbes, (Edinburgh University, Scotland) at the Department of Physics, University of Delhi.

## Missing universe may be merely invisible

For years, cosmologists have been saying that a big chunk of the universe is missing. Now three astrophysicists of the Indian Institute of Science, Bangalore, claim, they know where to find the missing matter.

They say the missing universe is actually contained in the bleak vacuum which is not "empty", and the missing matter resides there but is invisible.

Scientists of the 19th century believed that vacuum was filled with a mysterious substance called "aether." They visualized that the medium of aether was necessary to propagate light just as air is needed to propagate sound.

But the concept of aether as a medium sustaining light waves was discarded after the advent of Einstein's Special Theory of Relativity some 70 years ago.

The scientists, Mr. K.P. Sinha, Dr. C. Sivaram and Mr. E.C.G. Sudarshan, have now proposed a revolutionary model of aether.

According to them, aether does exist. And they claim that this aether is indeed a "sea" of electron and proton-like particles and their "mirror images" called antiparticles.

The missing universal matter is hiding in the seas of these particles. The particles and their antiparticles move in "pairs" and this

pairing effect makes the sea "superfluid", the scientists say.

The invisible superfluid state of particle-antiparticle pairs "would account for the missing matter of the universe," they say in a paper published in the American journal—*Foundations of Physics*.

---

## LONG LONG AGO

---

## Unesco symposium on bronze age in Asia set for Bangkok

Research on bronze age cultures in east and south-east Asia is the subject of an international symposium being held in Bangkok this 5 to 9 July. Organized by Unesco, the meeting will bring together specialists from Burma, Indonesia, Japan, the Republic of Korea, Philippines and Thailand.

According to Thai scholars, archaeological finds at Ban Chiang in north-east Thailand indicate that it may have been the site of the oldest human society with a developed technology, possibly dating back to about 5500 B.C.

*Unesco Features*

---

## EDUCATION IN ASIA

---

## Curriculum for development

*Sub-Regional Workshop, Colombo  
October 1-30, 1976*

WITH a view to linking up school curricula of the developing Asian Countries for grades 6

through 9/10 with the national development, the Sub-Regional Workshop was organized by the Asian Centre of Educational Innovation for Development, Unesco Regional Office for Education in Asia, Bangkok, Ministry of Education, Sri Lanka and Sri Lanka Foundation Institute. The Workshop was held in Colombo during October 1-30, 1976.

The participants were drawn from Afghanistan, Bangladesh, India, Indonesia, Malaysia, Philippines and Sri Lanka. The aim of the workshop was to provide the participants experiences in the analysis of the curriculum materials, foster awareness of alternative approaches to achieve educational goals and provide some experience in developing sample instructional material in the specified areas of health/nutrition, employable skill development and rural transformation.

#### *Objectives of the Workshop*

The objectives of the Workshop were:

- (i) Acquainting the participants with curriculum projects relating to health/nutrition, prevocational skill development and rural transformation.
- (ii) Development of competence in evolving criteria for curriculum analysis.
- (iii) Learning the techniques of curriculum analysis, design and development.
- (iv) Development of skills of curriculum revision through the application of criteria for curriculum analysis.
- (v) Practical experience in the development of instructional materials in the above three areas.

#### *Outcomes of the Workshop*

The activities undertaken by the participants during the whole course of the Workshop

were divided into following four phases:

*Phase I*—In this phase the participants discussed in details the suggested criteria, the method of analysis of curriculum and guidelines for developing and using criteria at national level.

*Phase II*—Exchange of inter-country experiences on the basis of the examination and analysis of national curricula of the respective countries and synthesis of experiences in developing and examining curricula in the three specified areas of health/nutrition, skill development and rural transformation.

*Phase III*—The study-cum-observation visits to the following projects undertaken by the schools in Sri Lanka:

- (a) Mahasen Vidyalaya (Senior School), Nikaweratiya, to study a project in rural transformation.
- (b) Bodhiraja Maha Vidyalaya (Senior School) and neighbouring villages to participate in a school health and nutrition Curriculum workshop and to study the community survey programme.
- (c) Majuwana Kanistha Vidyalaya (Junior School) to observe the out-of-school youth programme and Mawadivila Hand-Made Paper Unit.
- (d) Hedunawa Madhya Maha Vidyalaya (Senior School) to study a school programme in skill development rural transformation.

*Phase IV*—The participants in three sub-groups undertook the following exercises:

- (a) Analysed sample curriculum materials.
- (b) Developed guidelines for data gathering devices to study the communities.
- (c) Discussed the possibility of using the above data to identify

the problems of curriculum development, and finally,

- (d) Developed the sample instructional material.

In the valedictory session, held on the 30th October, 1976, the final report of the proceedings of the workshop was adopted by the participants. (J. MITRA)





## Book Review

### *Teaching of Mathematics in Secondary Schools*

Dr. S.K. Chakravarty, West Bengal Board of Secondary Education

IN the past decade, significant changes have taken place in the curricula and teaching of school mathematics. Today we hear of what is called 'new mathematics' or 'modern mathematics' as contrasted with 'traditional mathematics'. The controversy is not yet resolved.

While discussing the aims and scope of teaching elementary mathematics, the author brings out the distinction between new and traditional mathematics—both in terms of objectives and subject matter. He warns against undue emphasis on new mathematics: "Some new mathematics may be useful but it should not be presented as a separate entity and in replacement of some useful traditional topics". The aims of developing higher mathematical abilities and promoting mathematical literacy for all children are equally stressed.

The recent changes envisaged at the secondary stage demand teaching of a few new topics

—algebra of sets, functions and relations, inequations, probability and statistics, transformation geometry, etc. The book provides essential background knowledge regarding these new topics, to help the teacher introduce them in the class with understanding. The rigour and reasoning involved in the teaching of the new concepts as well as some of the traditional topics has also been indicated.

The nature, structure, and processes of mathematics, and its practical applications in life, have been presented with valuable teaching suggestions. The book is a useful guide to orient teachers about extension of the frontiers of knowledge in the subject. The appendix, which provides information on early mathematics and mathematicians, is also quite informative.

The book, however, does not contain sufficient material on the methodology of mathematics teaching. Effective teaching of mathematics is difficult. The Discovery Approach and the Problem Solving Approach are new methods in the teaching of mathematics. Most teachers are ignorant of the implications of these approaches in the teaching of the new content. New trends in the methods of meeting individual needs, organizing drill work, assignments and testing are other important areas in which orientation of teachers is very necessary.

The language of the book is simple. A number of examples are given to illustrate the key concepts. It shall certainly be interesting and useful to teachers.

R.C. SAXENA



is analogous to angular momentum). A proton and a neutron each has an isotopic spin equal to  $\frac{1}{2}$ .

**Meson** : A group of unstable elementary particles with the rest masses between those of electrons and protons. Mesons may be of positive, negative or neutral charge. When charged, the magnitude of the charge is equal to that of an electron.

## Scientific Terms

### *Used in This Issue*

**Aether** : The hypothetical medium which was supposed to fill all space, postulated to explain the propagation of electromagnetic radiations.

**Black body radiation** : Radiation of all frequencies such as would be emitted by an ideal 'black body' which absorbs all radiation falling upon it. The radiation which it emits is a function of temperature only.

**Geocentric** : Having the earth as the centre; measured from the centre of the earth.

**Heliocentric** : Having the sun as the centre; measured from the centre of the sun.

**Isotopic spin** : A quantum number used to work out the properties of a group of particles, when the members of the group are identical in all respects except that of electric charge. (Here 'spin' does not imply rotation but

**Neutron** : An elementary particle which is a constituent of all atomic nuclei except that of normal hydrogen. It has no electric charge and has the mass of  $1.67482 \times 10^{-27}$  kg.

**Plasma (physics)** : The region in a discharge in gases in which the numbers of positive and negative ions are approximately equal. The term has been extended to include very hot ionized gas in which controlled thermonuclear reactions are carried out e.g. inside the sun. In such a plasma or fourth state of matter, the ionization is virtually complete and highly conducting.

**Proton** : A stable elementary particle with a mass of  $1.67252 \times 10^{-27}$  kg. and a positive charge equal to the magnitude of that of an electron. It is a hydrogen ion and is a constituent of all atomic nuclei. □